BULLETIN

OF THE

Society for the Promotion of Engineering Education

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EDITORIALS.

Attendance at Engineering Schools.—In the discussion of the report of the Committee on College Administration at Minneapolis interest seemed to center in the falling off in the attendance at engineering colleges. While some members considered that the falling off was only apparent the general impression seemed to be that it was real. Other statistics quoted in this number of the BULLETIN bear out the latter contention. We are inclined to agree with Dean Raymond in the inference that attendance at college bears some relation to the financial condition of the country, although the fluctuations are not synchronous therewith. Reference to the college notes this month indicates a rise in attendance amounting to a very fair percentage. This is undoubtedly due to the prosperity which followed the last financial depression.

Recommendations of the Committee on Administration.—Although the matter of attendance seemed to bring out the most animated discussion, the recommendations of the committee were well received. The first of these was designed to promote closer relations between institutions and the society. As a result institutional membership was inaugurated and at present enrollments are being made. Among the institutions already enrolled are Stevens Institute of Technology, Case School of Applied Science, Rhode Island State College, University of Kansas, University of Notre Dame, Worcester Polytechnic Institute, New York University, Georgia School of Technology, Throop College of Technology, the George Washington University, Harvard University and Syracuse University.

The committee's other recommendations cover the subjects of leave of absence for professors and educational publicity work in the industries, matters of vital importance for the future of technical education. It is remarkable how the committee's recommendations dovetail into the statements of the authors of most of the papers. The committee's report gave unity and coherence to the whole Minneapolis program.

Ideals in College Building Construction.—New buildings at the University of Illinois are so common as to arouse little comment. This university's remarkable ability to secure ap-

propriations from the legislature has enabled it to house itself most comfortably. The fact should not be overlooked, however, that these buildings are the result of long study. The state architects, the university supervising architect and the professors in charge, all coöperate in the study of building conditions. Dean Richards describes in his Minneapolis paper the kind of a building which he would like to have and he shows foresight in laying his plans before the Society in time to have the members' suggestions of value. His contention that college buildings have not received the attention given office buildings is undoubtedly borne out by the facts. Of course the conditions are different in the two cases. An office building must be supported by rents and business men will not rent offices that they do not like. Hence, every new office building is an epitome of best current practice. On the other hand college buildings were formerly put up with little regard to appearance or even to utility. Famous laboratories have been housed in discarded barns. In one case a well-known head of a department was in the habit, tradition says, of calling in some mechanics and laborers, seizing a level, and starting out to put up a new shop with only a general notion of the width and length in mind. Conditions are improving and will continue to improve as is indicated by the contrast between buildings erected for technical education twenty years ago and to-day.

Drawing as a Language.—Professor French, in his Minneapolis paper printed in this issue of the BULLETIN, uses the above happy figure. How many men, bursting with ideas which they cannot express in words, are eloquent with chalk, pencil, brush! How much easier the approach to the mind through "eye-gate" than through "ear-gate." There are two sides to the study of a language, learning to express one's self in it and acquiring the ability to apprehend and visualize ideas expressed by others in the new language. So in drawing one learns to represent three-dimensioned objects, real or imagined, on flat surfaces and, still more important, to reconstruct the

three-dimensioned object by means of the trained imagination. All honor to the good teacher of those efficient trainers of the imagination, drawing and the one-time student-hated descriptive geometry!

The First Technical School.—Although it is somewhat late to refer to the commencement address delivered at Hobart College two years ago, by Dr. Andrew D. White, on the occasion of the unveiling of the monument to Dr. Benjamin Hale, the editor directs attention to this address for the purpose of putting its existence on record in the BULLETIN.* As a result of a careful study of documents Dr. White shows that Benjamin Hale was the first to introduce technical education in this country. Dr. White consulted a series of printed documents preserved in the College of Bowdoin which included the prospectus for a proposed technical school which was incorporated in 1822. This was known as the Gardiner Lyceum and it was in full operation with a goodly number of students early in 1823. At this time Mr. Hale was the main instructor and at times the only instructor, for those were the days when the whole range of sciences were thought to be in the powers of a single professor. Dr. White states that "there is ample evidence that his work of four years at Gardiner was thoroughly good, but the times were not ripe for such an effort; the stupidity and stinginess of legislators could not be long overcome; legislative means of support were at last withdrawn, and the Gardiner Lyceum, the first coherent effort to carry out an adequate plan for bringing the physical sciences to bear upon the industries of this country, after doing good work during about ten years, faded from view. None the less, the place of that young college tutor in the history of education and of his country is secure; it is fixed—fully and irrevocably; the organizer of the first school for technical education in the United States, the precursor of that vast system which has spread with such effect through every state of the American union, and far beyond it, was Benjamin Hale."

* Copies of Dr. White's address can undoubtedly be secured by addressing the authorities of Hobart College or Dr. White himself at Ithaca, N. Y.

APPLICANTS FOR MEMBERSHIP.

INDIVIDUALS.

ALLEN, F. G., Instructor in General Engineering Drawing, University of Colorado, Boulder, Colo. 1913

BLAIR, T. A., Instructor in Civil Engineering, College of Engineering, University of Colorado, Boulder, Colo. 1913

CRAWFORD, I. C., Instructor in Civil Engineering, University of Colorado, Boulder, Colo. 1913

DENNY, GEO. H., President, University of Alabama, University, Ala. 1913

DOMONOSKE, A. B., Instructor in Machine Design, University of Illinois, Urbana, Ill. 1913

GALLALEE, J. M., Professor of Mechanical Engineering, University of Alabama, University, Ala. 1913

KEGERREIS, ROY, Instructor in Electrical Engineering, University of Pennsylvania, Philadelphia, Pa. 1913

KELLER, R. B., First Assistant in Engineering Experiment Station, University of Illinois, Urbana, Ill. 1913

MITCHELL, LOUIS, Assistant Professor of Civil Engineering, Syracuse University, Syracuse, N. Y. 1913

NAIDU, A. S., Assistant Engineer, Vizianagaram City, Vizagapatam District, Madras, India. 1913

PHILLIPS, H. C., Valuation Engineer, Atchison, Topeka & Santa Fé Railway Co., 1033 Railway Exchange Bldg., Chicago, Ill. 1913

POTTER, J. C., Instructor in Electrical Engineering, Purdue University, Lafayette, Ind. 1913

THOROUGHGOOD, R. W., Professor of Civil Engineering, University of Florida, Gainesville, Fla. 1913

WALTERS, G. D., In charge of Duty of Water Investigations, Irrigation Branch, Dept. of Interior, Calgary, Alberta, Canada ... 1913

INSTITUTIONS.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif., Benjamin I. Wheeler, President 1913

CASE SCHOOL OF APPLIED SCIENCE, Cleveland O., Chas. S. Howe, President 1913

CLEMSON A. & M. COLLEGE, Clemson College, S. C., W. M. Riggs, President 1913

THE GEORGE WASHINGTON UNIVERSITY, Washington, D. C., Chas. H. Stockton, President 1913
GEORGIA SCHOOL OF TECHNOLOGY, Atlanta, Ga., K. J. Matheson, President 1913
HARVARD UNIVERSITY, Cambridge, Mass., Abbott L. Lowell, President 1913
IOWA STATE COLLEGE, Ames, Ia., Raymond A. Pearson, President.. 1913
THE UNIVERSITY OF KANSAS, Lawrence, Kans., Frank Strong, President 1913
MIAMI UNIVERSITY, Oxford, O., R. M. Hughes, President 1913
NEW YORK UNIVERSITY, New York, N. Y., Elmer E. Brown, President 1913
THE UNIVERSITY OF NORTH DAKOTA, Grand Forks, N. D., Frank L. McVey, President 1913
UNIVERSITY OF NOTRE DAME, Notre Dame, Ind., John Cavanaugh, President 1913
RHODE ISLAND STATE COLLEGE, Kingston, R. I., Howard Edwards, President 1913
ROCHESTER ATHENAEUM AND MECHANICS INSTITUTE, Rochester, N. Y., Carleton B. Gibson, President 1913
STEVENS INSTITUTE OF TECHNOLOGY, Hoboken, N. J., A. C. Humphreys, President..... 1913
SYRACUSE UNIVERSITY, Syracuse, N. Y., James R. Day, Chancellor. 1913
THROOP COLLEGE OF TECHNOLOGY, Pasadena, Calif., Jas. A. B. Scherer, President..... 1913
U. S. NAVAL ACADEMY, Annapolis, Md., Captain John H. Gibbons, Commandant 1913
WORCESTER POLYTECHNIC INSTITUTE, Worcester, Mass., Ira N. Hollis, President..... 1913

SOCIETY BUSINESS.

Dean C. R. Richards and Professor Hugo Diemer were appointed the Society's delegates to the seventh annual convention of the National Society for the Promotion of Industrial Education. Their report will appear next month. Dean Herman Schneider was also appointed but was unable to attend.

President G. C. Anthony last month made a tour of several centers of society interest in order to post himself thoroughly on the work to be done this year. Among the cities included in

his tour were New York, Ithaca, Pittsburgh, Columbus, Cincinnati and Cleveland.

ERRATUM.

On p. 2 of Part I of the September BULLETIN the editor stated that the Minneapolis meeting was the beginning of the twentieth year of the Society's activities. The current year is actually the twenty-first year, the first meeting having been held in connection with the World's Engineering Congress at Chicago, July 31 to August 5, 1893.

PAPERS IN PREPARATION FOR THE BULLETIN.

AUTHORS.	TITLES.
Austin, F. E.	Automatic Mapper.
Benjamin, C. H.	Cost of Educating a Student.
Berg, E. J.	Interesting Students in Mathematics.
Bishop, F. L.	Lack of Supervision of Engineering Students Working in Summer Vacation.
Blanchard, A. H.	Coöperation in Research between University Road Materials Laboratories.
Caldwell, F. C.	High Tension Laboratory of the Ohio State University.
Conkling, L. D.	Test of a Bethlehem "H" Section.
Davis, E. W.	Desirability of Broad General Training.
Elliott, B. G.	University Extension Field for Engineering Teachers.
Fish, E. H.	Calculus Needed in Strength of Materials.
Frost, A. G.	Employment as Affected by Technical Education.
Harding, C. F.	Student Grading, by Universities *vs.* by Employers.
Higbie, H. H.	Studies in Problem Construction.
Moss, S. A.	Mathematics for Engineering Students.
Raymond, F. N.	The Common Purpose of Various Departments—Coöperation.
Riggs, W. M.	Student Character Records.
Russell, W. B.	Laboratories to Fit the Needs of Working Men.
Shenehon, F. C.	The College Year for Technical Schools.
Telleen, J. M.	Engineering English.
Thaler, J. A.	Wireless Telegraphy.
Tilden, C. J.	New Buildings for the Technical School of the Johns Hopkins University.
Yeoman, R. C.	Teaching German in Technical Colleges.

PERSONALS.

Professor G. B. Thomas, of Colorado College, was married at Garland, N. C., on August 21, to Miss Mary Wright.

Mr. A. S. Naidu, who has just joined the Society, has had important connection with important public works in the Madras presidency. He is at present assistant engineer of the city of Vizianagaram.

Professor A. H. Blanchard and Mr. Prevost Hubbard formed a partnership under the firm name of Blanchard & Hubbard, Highway Efficiency Experts, with offices at Broadway and 117th St., New York City.

Dean E. B. McCormick, formerly professor of experimental engineering and dean of mechanic arts of Kansas State Agricultural College, Manhattan, Kans., has resigned his position and is now mechanical engineer at the office of public roads, U. S. Department of Agriculture, Washington, D. C.

Mr. W. H. Freedman, formerly head of applied electricity at Pratt Institute, Brooklyn, N. Y., has accepted the professorship of electrical engineering at the University of Vermont, Burlington, Vt.

Professor C. D. Howe, formerly professor of civil engineering at the University of Dalhousie, Halifax, N. S., has given up teaching work and is now chief engineer, Board of Grain Commissioners for Canada, Fort William, Ontario.

PUBLICATIONS RECEIVED.

The Electric Railway Journal, in its issue for October 4, publishes a 110-page treatise on current practice in electrical traction. This will be of value to teachers and classes in electric railways.

The Zeitschrift des Vereines deutscher Ingenieure, for July 19, devotes three columns to a review on the report of the Committee on Teaching Mathematics to Engineering Students, referring to the necessity for getting out already a second edition. A digest of the review will be printed next month.

The Princeton Engineering Association has issued its regular annual booklet giving information regarding alumni and the constitution of the association.

Professors Franklin, MacNutt and Charles have privately printed an article originally designed for *Nature* and afterward accepted by *Science* giving in interesting style more detail of their well-known views on teaching mathematics. Their arraignment of the mathematical ability of technical students is severe.

The Superintendent of Documents, Government Printing House, Washington, D. C., has issued a circular listing national park publications describing geological and other features of our national parks. These are distributed at nominal prices. The Secretary of the Interior has for free distribution descriptive circulars relating to all of the national parks.

The Engineering Index now contains regularly references to the papers delivered before the Society. These are classified in the several engineering branches. Some of the references are found on pages 132, 141 and 165 of the October *Engineering Magazine.*

The Mellon Institute of Industrial Research has issued Smoke Investigation Bulletin, No. 4, entitled "The Economic Cost of the Smoke Nuisance to Pittsburgh," by J. J. O'Connor, Jr. The cost is analyzed as that to the individual, to the household, to wholesale and retail stores, to quasi-public buildings and miscellaneous. The total cost is estimated at about $10,000,000 per annum and the statement is made that this is not really the entire cost.

COLLEGE NEWS.

University of Alabama.—An important organization is the Engineers' Club now entering its second year with 16 new members enrolled. It was organized February 18, 1913, with 36 charter members. It has the usual purposes of engineering societies among technical students. Last spring lectures were delivered before the Club by Mr. Jonathan Haralson, of Birmingham, on the Edison Storage Battery, by Mr. Henninger, of the Buckeye Lamp Works, on Illumination, and by Dr. E. A. Smith, Dean Geo. J. Davis and Professor G. F. Wittig, of the faculty. At other meetings talks were given by students. Audiences as large as a hundred were sometimes present.—Inspection trips were made, under the auspices of the Club, to

the mill and model city of the Kaul Lumber Co., to the plants connected with the iron and steel industry at Holt, Ala., and to the great dam and locks under construction by the government at "Lock 17" on the Black Warrior River. The Club also had charge of the publication of the annual engineering number of the University weekly, *The Crimson-White,* and produced a very creditable issue which was widely circulated in the state. The business meetings of the Club were followed by brief social sessions, four being held during the term, and the activities of the year were brought to a close with a "dutch supper" at the McLester Hotel in Tuscaloosa.

Colorado College.—Messrs. R. R. Tileston and M. A. Blakey have been appointed to the faculty of the engineering department.—A $100,000 men's building is under construction. It contains an indoor gymnasium, an outdoor gymnasium, locker rooms, reading rooms, meeting rooms and a dining room.

Columbia University.—The Navy Department at Washington has detailed eighteen naval officers having the grade of lieutenant to attend a postgraduate course in engineering at Columbia University. These men graduated from Annapolis from five to eight years ago and after several years in active service have been selected for their aptness in engineering lines. They have already spent one year in the postgraduate school at Annapolis, where they received a general engineering training, and have been sent to Columbia to specialize in their various lines. Of these men nine will take a course in electrical engineering, seven in mechanical engineering and two in radio engineering. The work done by all the individuals of a group will be the same, but the three different courses have been arranged particularly to meet the probable future needs of these officers.—In connection with the work in wireless, a friend of Columbia University has donated a sum of money to improve the equipment of the research laboratory in wireless telegraphy and for the erection of a proper equipment for receiving and sending wireless messages, including what will probably be one of the most sensitive receiving stations in New York City

proper. The wireless men will work under Professor Pupin, who has been carrying on research work in this line for some time, and who will be assisted by Professor Morecroft.—The nine students in electrical engineering will take work under Professor Slichter and Professor Arendt for their major subjects and those in mechanical engineering under Dr. Lucke and Professor Rautenstrauch.—The courses were laid out from suggestions of the heads of the departments at Columbia and by conferences between Lieutenant-Commander Morton, head of the postgraduate school at Annapolis, and Dean Goetze of Columbia University.

Franklin Union.—Professor D. L. Gallup, of Worcester Polytechnic Institute, Professor J. C. Riley, of Massachusetts Institute of Technology, and Professor C. E. Stewart, of Franklin Union, were a special committee of experts to represent the National Board of Fire Underwriters at the Forty-first Annual Convention of Fire Engineers, held in New York, in September. The apparatus tested included all the new types of automobile pumping engines.

University of Illinois.—Acting Dean C. R. Richards, who is taking Dean Goss's place while the latter is in Chicago, has announced the following appointments to the faculty of the college of engineering: L. H. Provine as professor of architectural engineering; L. A. Harding as professor of experimental mechanical engineering; A. C. Willard as assistant professor of heating and ventilation; Percy Ash as assistant professor of architectural design; W. C. Titcomb as assistant professor of architecture; E. A. Holbrook as assistant professor of mining engineering; J. I. Parcel as assistant professor of structural engineering; W. M. Wilson as assistant professor of structural engineering; P. S. Biegler as associate in electrical engineering; S. O. Andros as associate in mining engineering; J. H. Forsythe as instructor in architecture; A. B. M. Corrubia as instructor in architecture; A. R. Knight as instructor in electrical engineering; Rufus Crane as instructor in general engineering drawing; H. W. Waterfall as instructor in machine

design; F. C. Torrance as instructor in mechanical engineering; H. E. Babbitt as instructor in municipal and sanitary engineering; Harry Gardner as instructor in theoretical and applied mechanics; Alexander Vallance as instructor in theoretical and applied mechanics; L. E. Young as part-time instructor in mining engineering while carrying on graduate work in economics; R. B. Keller as first assistant in the engineering experiment station, department of railway engineering; Sebastian Karrer as assistant in physics; B. L. Bowling as assistant in the cement laboratory in the department of civil engineering; J. B. Nathanson as part-time assistant in physics; J. H. Belt as research fellow in the engineering experiment station, department of electrical engineering; Julian Montgomery as research fellow in the engineering experiment station, department of theoretical and applied mechanics, and R. B. Pogue as research fellow in the engineering experiment station, department of railway engineering.

Lafayette College.—The work opens up with an increased registration, the freshman class numbering 212, 54 per cent having registered for engineering.—Several important changes have been made in the faculty: Dr. S. A. Martin, formerly president of Wilson College, Chambersburg, Pa., and other Pennsylvania educational institutions, becomes professor of mental and moral philosophy; Mr. J. W. Lewis has been made assistant professor of electrical engineering; Mr. Elbert Ross, instructor in chemistry; Mr. C. E. Pearse, instructor in mechanical engineering; Mr. T. A. Garretson, instructor in chemistry; Mr. F. W. Slautz, instructor in graphics; Mr. L. W. Van Buskirk, instructor in mechanics and materials; Mr. C. R. Wasser, instructor in pattern shop; Mr. Wm. Wallaesa, instructor in foundry, and Mr. A. L. Logan, instructor in forge work. Other changes have been made in affiliated departments.

University of Maine.—The department of electrical engineering is making several alterations in its laboratory which will greatly facilitate the carrying on of experimental work. The more important additions will be the installation of a

three-unit motor-generator set for furnishing the laboratory power, and a six-panel switchboard. The set will consist of a 2,200-volt synchronous motor, direct connected to a three-phase alternator and a direct-current generator. These three machines will be controlled from three panels of the switchboard, the three remaining panels being used to control a synchronous converter and the laboratory distribution of power. The switchboard is being designed by the department and will be constructed and erected by the students taking the electrical engineering course. The machines are to be furnished by the General Electric Co., and the switchboard instruments by the Westinghouse Electric & Mfg. Co.

North Carolina A. & M. College.—Practically the entire student body voluntarily submitted to vaccination against typhoid fever resulting in a very comfortable feeling on the part of the college authorities.—A 12 per cent increase in attendance is noted, the most remarkable gain being in electrical engineering, which has now the largest enrollment with the exception of agriculture. A noticeable feature is the registration of a large number of graduates from rural high schools which are preparing their students thoroughly for college work.—Last month ground was broken for a new shop building to cost about $50,000.

The Ohio State University.—The electrical laboratory has received the high-tension equipment used by Mr. R. D. Mershon in his famous corona experiments at Niagara Falls. Professor Caldwell will describe this equipment in an early number of the BULLETIN.

Pratt Institute.—The demand for instruction has been so great this year as to necessitate turning away many applicants.—A new course in trade teaching has been instituted in charge of Mr. W. A. O'Leary.—Mr. J. A. Randall is now acting dean of the department of physics in place of Mr. J. M. Jameson. Mr. P. B. Winn has been appointed instructor in physics.—Among other appointees are Mr. Lincoln Burrows, instructor in chem-

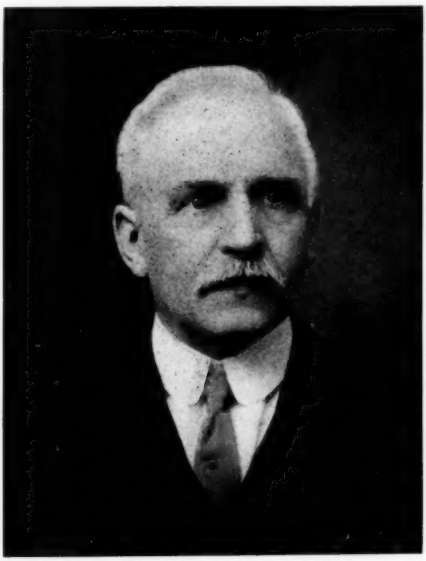
istry; Mr. E. T. Marlatt, instructor in mathematics; Mr. W. E. Lindsay, who is reappointed to an instructorship in machine design.

Princeton University.—At the annual election for an alumni trustee in June, 1913, Howard C. Phillips, C.E. '90, was elected for the regular term of five years.—At the time of this election, there was not an engineer on the board of trustees. The election was a spirited contest. Mr. Phillips was proposed and advocated on the ground that a practicing engineer on the board of trustees could be of great service to the University. Mr. Phillips is valuation engineer of the Santa Fe system and has his office and residence in Chicago. He has just applied for membership in the Society.—A committee of the Federation of Princeton Associations of New Jersey is working out a plan to establish a chair in engineering chemistry at the University. Mr. Jasper E. Crane, Arlington, N. J., is secretary.

Virginia Polytechnic Institute.—Messrs. Carneal and Johnston, architects and engineers, of Richmond, Va., have presented tentative plans to the engineering faculty for the shops to replace those destroyed by fire during commencement week.—The building is to be of collegiate Gothic type of architecture, having 50,000 sq. ft. of floor space. The administration end is two-story, the remainder being of one-story saw-tooth roof construction. This building is to house the wood-working, foundry, forge and machine departments.—Mr. R. H. Begg, formerly professor of sanitary engineering at the University of Kansas, has been appointed to the chair of civil engineering, which has been vacant for the past year.

Washington University.—The initial registration in the schools of engineering and architecture showed a gain of six per cent over the corresponding figures of last year. For the last four years the increase has been steady, averaging about eight per cent per annum.—In the department of electrical engineering, the vacancies created by the resignations of Mr. G. W. Lamke, assistant professor, and C. H. Hardy, instructor, have been filled by the appointment of Mr. H. G. Hake, for-

merly of the University of Illinois, to the assistant professorship, and of Dr. Wm. B. Kouwenhoven to the instructorship.—The same department has recently completed the construction of a 60-kva., 250,000-volt testing transformer, and is now at work on the construction of a 5-kw. wireless telegraph station, which will have an aerial 350 feet long and 100 feet above ground. Work is about to be resumed on the investigation of pole-face losses in generators and motors by means of a special machine built last spring.



GARDNER C. ANTHONY, TWENTY-FIRST PRESIDENT OF THE SOCIETY.

On account of Dean Anthony's absence in Europe he was unable to attend the Minneapolis meeting, hence was not a member of the group of officers and members which formed the frontispiece in the September BULLETIN. By obtaining his portrait under false pretenses the Editor has been able to insert it here as an introduction of Dean Anthony to the members who have not met him.

DEPARTMENTAL ORGANIZATION.

BY HUGO DIEMER,

Professor of Industrial Engineering, The Pennsylvania State College.

An important feature of modern industrial organizations developed as the result of the investigations made within the last few years relating to the application of the principles of scientific management to administrative problems is the complete remodeling of positions of higher responsibility.

It has come to be a recognized feature of successful industrial organizations that there must be opportunity for progressive promotion continuously throughout the active life of service of the more responsible heads. A recognition of this principle has resulted in the creation of numerous general administrative offices in the larger industrial and railway corporations. It was recognized that one of the worst features of specialization and departmentalization was that a capable man progressed and was promoted until he came to be head of a specialized department. Having reached this goal he was confronted by a stone wall under the old system of organization. As indicated, in the larger industries and railway corporations this condition has been remedied. Unfortunately in educational work it has not been remedied. We have gone on increasing the number of departments, sub-dividing existing departments, removing from the jurisdiction of the department head everything excepting the bare technology of his specialty.

Until we recognize that department heads should be men with human interests, men who are active citizens, who take an interest in the economic, social and even political aspects of their profession, we must expect popular fiction to abound with caricatures of college professors, cartooning them as narrow individuals who have no interest in the world outside of

scarabees and similar minute specialties. This defect in the educational organization largely accounts for the fact that men with the kind of instincts and abilities which tend to make them individuals of the type known as men of affairs do not remain in educational work, unless the rare opportunity arises of securing positions where they can obtain rank and salary together with adequate responsibilities and broad interests worthy of men of their type.

To indicate how we have narrowed our responsibilities we need but glance for a moment at the comprehensiveness of the old-time department of civil engineering. At present we have instead of a department of civil engineering, specialized departments in mechanics, highway engineering, sanitary engineering, hydraulic engineering, etc. Similarly in the case of mechanical engineering, instead of the old-time professors, who were recognized leaders in the country and familiar with the broader economic and social aspects and their work, we have now professors of thermodynamics, of machine design, of steam engineering and of other sub-specialties.

The same is true in the college of liberal arts. Under the old organization the professor of history was an all-around broad-gaged man, who understood economics and politics. Under the present organization we have distinct departments of economics, political science and various sub-departments in history, such as American political history, European constitutional history, etc.

I suggest as a most desirable question to be answered by a committee to be appointed by this society the following:

"How can we plan a system of departmentalization and promotion in the colleges so that there shall be continuous opportunity for progress for the capable man?"

IS ATTENDANCE AT ENGINEERING SCHOOLS FALLING OFF?

At the Minneapolis meeting of the Society the Committee on College Administration presented a preliminary report. The Committee was continued for another year and will bring in a final report at the Princeton meeting, the Program Committee having already set aside a 3-hour session for this purpose. In connection with the report there will be papers dealing with general aspects of the subject.

A small section of the Committee's report was devoted to attendance at engineering schools and the statistics were arranged in graphical form. They showed a falling off in attendance amounting to a startling amount from 1909 to 1913. The curve showing this condition is reprinted here from page 709 of the June BULLETIN.

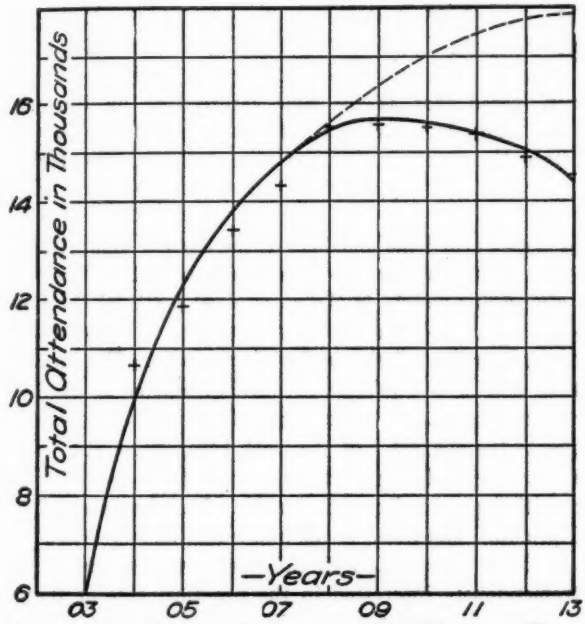
The Committee attributed the falling off to the following four reasons: The general raising of standards, the greater interest in agriculture, the greater interest in commercial courses and the prevailing opinion that the engineering profession is overcrowded.

Dean Bishop, chairman of the Committee, wishes to emphasize the standpoint of the Committee in regard to the falling off in attendance. The Committee believes strongly that the falling off is a good thing for the schools. It is, however, very unfortunate for the industries that fewer well-equipped technical men are being prepared for the great work of engineering and allied occupations.

While this topic was only one of a number presented in the report the interest in the discussion was focused upon it. A digest of the most important points made is as follows:

Professor J. E. Boyd stated that he was on the entrance board of The Ohio State University several years ago when they raised their entrance requirements. In spite of this

fact the attendance continued to increase for several years and he does not attribute the general decrease in attendance to changes in entrance requirements. He does, however, attribute some of the falling off to the increasing interest in agricultural and commercial courses. Professor O. L. Waller confirmed this conclusion particularly in regard to agricul-



Curve of Attendance at 55 Engi'g Schools

tural engineering in the far west. He stated that in that section of the country every commercial center, every board of trade is advertising the "back-to-the-farm" movement. Every public school is putting in courses in agriculture and horticulture. Colleges and universities are advertising similar courses. Every real estate man is advertising farms and

advising young men to buy land and cultivate it. The result is a great reduction in the number of students in engineering courses.

In response to a question from Mr. W. O. Wiley as to whether applicants for admission to the agricultural schools come from the farms or whether they are the sons of men engaged in other vocations, Dean W. F. M. Goss replied that more than one half of the students entering the College of Agriculture of the University of Illinois are from cities, many from Chicago. Continuing on this point, Principal A. L. Williston stated that at the time referred to by Professor Boyd, the students entering the Engineering College of The Ohio State University and other state colleges were largely sons of farmers. Today, however, but a small per cent are of this class.

Dean Goss warned the members of the Society against being disturbed over the tendency of the attendance curve to droop. While giving due weight to the reasons set forth by the Committee, he did not believe that any statement can give a complete representation of the underlying causes. Engineering education is still in a process of development as it has been since the beginning. It is in a transition period now, with reference to the character of the work being done, and to the impression which colleges are making upon their clientele. By this transition process Dean Goss referred to the change from the old practical education to the new scientific education. In the early days, particularly in the west, students and others were tremendously interested in the practical side of things. This point of view resulted in giving great prominence to the work of the shop and field, where a considerable degree of manual skill was acquired. The maximum point of the attendance curve corresponds to the epoch when this point of view produced its maximum effect. Gradually, however, the authorities of our colleges of engineering have come to feel that, while manual work is good, while it has a high educational value and is still worth while, it is not in itself suffi-

cient. The present-day student faces a more exacting intellectual test. The engineering college of today is endeavoring to give each student a higher quality of mathematical training, that his training as a scientist may be increased, and the engineering world is not quite up to its new standard. In time the men, thus prepared, will make their influence felt. The educators are at work on a process which is more or less new and is certainly full of meaning. The outcome is soon going to be apparent in the industrial activities of this country and when it is, the demand for our engineering graduates will increase. Then the attendance curve will curve upward again and the increase will be at a rate which will surprise us all.

Taking up another phase of the subject Dean C. M. Woodward called attention to the fact that, to a certain extent, the apparent falling off in attendance is due to the method of classification. Not many years ago all students studying architecture, chemistry or mechanics, for example, were grouped with the engineering students. As numbers increased and the different departments developed more complete courses of study, the groupings were changed. Now architects, chemical engineers and other allied divisions of students are not classed as engineers. Dean Woodward considered, therefore, that the results of investigation reported are somewhat misleading unless they were intended to include all students engaged in courses involving more or less engineering.

Dean W. G. Raymond called attention to a reason for the form of the attendance curve which had possibly been overlooked by the committee, namely, the financial panic of 1907. Dean Raymond stated that a year ago he had occasion to plot a curve of attendance running back some fifty years which he had studied with reference to financial depressions. The study covering this long period showed that depressions followed panics after intervals of from four to five years. The depression in attendance never coincides with the year of financial trouble. By means of this study Dean Raymond had

been led to predict the end of the present depression to occur about five years after the panic and this prediction seems to be warranted by the facts. He agreed with Dean Goss that the curve would show an upward tendency and that the depression is nothing to be troubled about particularly since salaries of engineering graduates have been on the increase during the past ten years.

Professor C. L. Crandall referred to the feeling which exists in some parts of the country that the engineering profession is overcrowded. In his opinion the inclination to license engineers is an evidence of this. This attitude is having its influence in directing young men to other fields. The interest in agricultural education has also an effect. The college of civil engineering at Cornell was at one time largely made up of students from farms. Of late the proportion of these has been diminishing and city boys are in much greater evidence. The back-to-the-farm movement is sending the boys to the agricultural college.

Dean M. S. Ketchum reinforced and illustrated the point made by Dean Goss and its effect on the demand for engineers. He stated that he had received from one of the engineers of a large railroad company a letter making the following statement: "I want men who have had theoretical training. We get better results from recent graduates without experience who have had modern theoretical training than we do from men who have had experience, but who have not had that training." Recent graduates are forcing the older men out of the profession as a result of their theoretical training. The older men, therefore, are forming trade unions and societies in the effort to hold their jobs. In the next few years there is going to be a cleaning-out process and the younger men with theoretical training are going to force out of the profession a large number of engineers who have not had such training or who graduated from college fifteen or twenty years ago and have allowed their theory to lapse. Dean Ketchum said that in his own line of work, civil engineering, the requirements for

success in engineering are far in advance of those of fifteen years ago. Like Dean Goss, he believes that we are in a transition period after which there will be a large increase in attendance and additional demands upon the college. The demands will be for more theory, leaving the students to get their practical experience later.

President Magruder, in closing the discussion, expressed the opinion that the supply of engineering graduates is not by any means equal to the demand. When one considers how manufacturing companies send their best men to study the graduating classes of our technical schools, interviewing students and offering opportunities to the best, it is evident that there is a demand for the technical graduate. We have heard a great deal regarding the fact that the technical graduate is worthless for several years after graduation. Why is it then that the companies seem so anxious to get them? The fact is that this demand for the technical graduates has a tendency to give them an undue estimate of their own importance. President Magruder, in referring to the effect of the agricultural college on the technical school attendance, emphasized the fact that the technical schools have all the students that they need. At the same time the technical schools are very poor advertisers as compared with the agricultural schools. If engineering schools would send out special trains giving instruction on the use of high grade steel, the construction of the latest types of levels, the newest methods of testing materials, the newest test for ascertaining the sanitary conditions of water and such matters, possibly the returns might be as large as they are from similar efforts by the college of agriculture. The latter are teaching the engineers a good lesson. At the same time President Magruder emphasized the point that it is better to do good work for a small number of fine students than to do mediocre work for ten times as many.

In connection with the report of the Committee on College Administration it is of interest to consider the statistics which have been published for the past seven years by the *Electrical*

World. The tables of data may be found in the issues of July 27, 1907, December 26, 1908, February 10, 1910, December 22, 1910, November 11, 1911, November 23, 1912, and October 18, 1913. In a general way the conclusions of the committee are verified by the extensive *Electrical World* canvass. The latest tables follow.

TABLE I.

ELECTRICAL ENGINEERING STUDENTS AND GRADUATES.

	Number of Schools.	Students 1912-13.	Graduates 1913.	Total Graduates to June, 1913.
Class I.....	25	3,373	533	9,854
Class II.....	71	4,284	598	7,154
Class III.....	19	1,486	235	3,038
Totals.....	115	9,143	1,366	20,046

TABLE II.

COMPARISON OF STATISTICS FOR SEVEN YEARS.

Year.	1907.	1908.	1909.	1910.	1911.	1912.	1913.
Number of students.....	8,929	9,651	8,670	9,041	9,515	8,921	9,143
Number of graduates.....	1,358	1,501	1,473	1,545	1,614	1,442	1,366

TABLE III.

STATISTICS OF POSTGRADUATE AND UNDERGRADUATE STUDENTS IN 1912 AND 1913.

Year.	Class.	Freshmen.	Sophomores.	Juniors.	Seniors.	Postgraduates.	Total Students.	Graduates.	Total Graduates.
1912	First	1,113	866	728	604	122	3,433	611	9,321
	Second	1,538	1,034	775	685	47	4,079	530	7,556
	Third	522	378	267	221	21	1,409	301	2,803
Grand totals...		3,173	2,278	1,770	1,510	190	8,921	1,442	18,680
1913	First	1,069	833	767	591	113	3,373	533	9,854
	Second	1,598	1,103	808	674	101	4,289	598	7,154
	Third	475	366	366	276	3	1,486	235	3,038
Grand totals...		3,142	2,302	1,941	1,541	217	9,143	1,366	20,046

CORRELATION OF EDUCATION WITH LIFE WORK.

BY GEO. L. SULLIVAN,

Professor of Mechanical Engineering, University of Santa Clara.

The function of an engineering education is to impart training, knowledge and experience to the student that will render his life work more efficient and if engineering education is to fulfill this function in a high degree it must be closely correlated with the work that engineers are called on to do. Our present system is not a development of a rational study of the work of engineers; rather it is a modification of the scientific course which was given with the injunction to study for the sake of science and not because it might function in the performance of any work. This course was modified to make it more useful, but the modification was first done by teachers of science who had no practical experience in engineering work. Later their students, who were primarily interested in engineering, took up the work and modified the course further until we have the present result.

Evidences of Lack of Correlation.

There has never been a definite correlation of engineering courses and engineering work, a tabulation of the things that an engineer must do, and of the corresponding courses that will train him to do them; neither has there been an investigation of the things that the courses that are given will enable one to accomplish. If a turret lathe is set up, the operator can tell exactly what each tool is for; one for turning, another for boring, another for threading, but there are many engineering courses given for which there is little or no definite use in engineering work and often when there is a definite use for a

subject neither the author nor the student learns how to apply it. Some of the attempts of mathematicians, for instance, to find practical applications for their courses are pathetic and sometimes lead to odd results. I have seen a graduate student cover a panel of blackboard with differential equations in solving a problem whose complete solution is indicated by the operation $\pi(100+20)^2\times 5=72{,}000\pi$ (see problem 11, page 40, in Mellor's "Higher Mathematics"), yet he had completed a course in civil engineering at a well-known state university. He was mathematician enough to juggle the equations according to directions but it is doubtful if his knowledge of calculus would help him out of a practical difficulty, in fact there was something radically wrong with his training or his knowledge would have enabled him to see the proper analysis of the problem and its very simple solution.

The Aim of Education.

Professor Mead states that the aim of true education is to increase the ability to acquire information, to analyze a problem, to investigate the conditions which surround it and to determine the fundamental principles on which a successful solution depends. Mr. Lee expressed much the same thing when he said that one of the primary needs of technical graduates is judgment. Other engineers have said the same thing in different words and it is doubtful if this view could be seriously controverted.

Having a clear idea of the aim of education, we can examine existing courses and propose changes that will produce the ideal course. This is presumably what the committee did when they formulated the "Syllabus of Mathematics" for they say that the "Syllabus" is intended to include those fundamental principles which, in the opinion of the committee, should constitute the minimum mathematical equipment of the student of engineering. If this is so, the committee must have had in mind a definite use for every subject included in the "Syllabus," but the introduction and the clause "in the opinion of

the committee'' indicate that the ''Syllabus of Mathematics'' is a development of the best judgment of a number of men without a detailed study of the actual needs of engineering students. Isn't it exactly comparable to what a number of foremen would have written on the art of cutting metals before Taylor made his study of the subject? I do not like to criticize the ''Syllabus''; it is the best thing we have in that line, but it is probable that an attempt to correlate mathematics and engineering would result in a further improvement. Opening the book at random, we find on page 71 a chapter on polar coördinates. Now has anyone considered just why a study of polar coördinates should be required of every engineering student, just where he will use his knowledge of the subject and what per cent of the men, of whom it is required, will use it. If it is of use only in very special cases, why not require it only in special courses covering these cases?

I am assuming that all engineering courses are given for utilitarian purposes only, that physics and chemistry give the engineer a knowledge of the laws of nature which apply to his work, that mathematics is given to facilitate his application of general laws to specific cases, that history is given to enable him to better judge the large problems that present themselves to him as a citizen, that literature and English are given to enable him to enjoy and profit by the written word of others and to properly express his own thoughts. In short that all courses are given that they may function in his future work as a man and as an engineer. I do not say that a knowledge of polar coördinates should not be required of all engineering students, though I doubt it, but I would like very much to know by just what process the committee arrived at the conclusion that polar coördinates is valuable enough to an engineer to require it of all engineering students.

Methods of Instruction.

Having determined on a proper course of study, we are then ready for the problem of finding the simplest way of imparting

the necessary training in a subject to the student. The mind of the entering student and the information he is to acquire is the raw material, the developed (?) mind of the graduate is the finished material, and the student himself is the workman. The textbook author and the department head should run the planning department and the instructors should be functional foremen. The student should be given detailed instructions as to what he should do with the assurance that if he follows instructions he will gain the desired mastery of the subject with the least effort. The duty of the instructor is to see that the student knows how to follow instructions and not, as is often the case at present, to act as a mechanical conveyor of information and as an inspector of the finished product.

If a coach wishes to develop a sprinter he gives him definite instructions as to what he is to do. If he wishes to develop a pole vaulter he does not think that his duty is done if he sets the standards at twelve feet and comes back the next day to see if the candidate can clear the bar. Yet in a class room, too often, the procedure is to assign the next ten pages and to examine the student the next day to see whether he waded through or not. I realize that this is not always the case and that there is some real efficient teaching, but it is not the rule.

Students should be told exactly what is the best method of attacking a lesson, because I believe there is a best method for everything and that the results will be fairly uniform if the proper method is followed. Quoting from the "Syllabus of Mathematics": "The committee is firmly of the opinion, that whatever order is adopted, the principal part of the course should be problems." It would seem that this is as definite information as there is on the subject, for the men who composed the committee undoubtedly are among the best-informed men in that line in the country. You can imagine that if the shop foremen had written a syllabus on the "Art of Cutting Metals" they would have said that lathes should be run at a high speed to get the best results. I do not mean all this as a

criticism of the "Syllabus" except as it represents the present state of the art of teaching engineering.

A Definite Method of Instruction in Mechanism.

In the preparation of assignments from texts, students have a very good chance to exercise their ability to acquire information, to analyze a problem, to investigate the conditions which surround it and to determine the fundamental principles on which a successful solution depends. We can do a great deal in the line of Professor Mead's definition of true education by training students how to study properly. For example, the writer gives the following directions for studying the first chapter of Keown's "Mechanism":

Could a man who has anything to do with machinery get along very well without a knowledge of motion and velocity?

Read the chapter carefully and write down answers to the following questions when you come to the part of the chapter to which they relate.

Name machines which do not seem to fit the author's definition of a machine.

What relation does invention have to the three steps given in the design of machines?

What would be the effect if the crank end of a connecting rod were not controlled and constrained to move in a circle?

Is spherical motion important enough to devote a paragraph to it?

Can you think of any machine part that has a motion different from any mentioned?

What is the definition of rate?

Which is the more important, to know the path of a part of a machine or to know its velocity?

Is it necessary to refer the motion of a body to a point in its own path to find its linear velocity?

Do machine parts often have uniform velocity?

Check the rule at the bottom of page —.

Learn the italicized rule on page —.

What is the most important thing in the chapter?

Solve problems 1, 3, 6 and 10.

A student who answers these questions as he studies the chapter will have exercised that ability which Professor Mead

gives as the aim of education. He will have treated the chapter much as he would a problem in engineering practice. Suppose his problem to be the lay-out of a power plant to fit conditions described to him by the prospective builder. First he would have in mind the object of his study of the problem—in order that he may be able to lay out the plant—just as the student must familiarize himself with motion and velocity if he is to design and handle machinery. The engineer then checks over the data and compares them with his own experiences and questions anything that his own experiences make him doubtful of; the student does the same thing with the statements of the author. The engineer then organizes the ideas he has obtained; he decides the important points, whether the first cost or operating expenses shall govern the design, and other points that he will have to keep in mind, and he memorizes some of the data that he will constantly use. The student will have in his mind a similar organization of the matter of the chapter and as finally the engineer will design the plant, so the student will work the problems.

It is not intended to outline each chapter as fully as is done here but rather to teach the student to attack his lessons in a systematic manner as he will have to attack the problems of later life. A very good treatise on the art of study is given in McMurray's book, "How to Study."

The Use of the Library.

Engineering students usually are given an adequate training in the use of instruments by which they may acquire local information but the immense store of information which is available through the use of card catalogues, the Engineering Index, the Reader's Guide, the Annual Literary Index and indexes kept by different universities is often a sealed book to them. They are usually given a lecture or two on the use of the library, when they are freshmen, but it is only when they are directed in making an exhaustive study of some point that they learn how to find what they need in the immense store

available. The use of a well-catalogued library is as important as the use of a laboratory in acquiring information.

Conclusions.

The scientific determination of the exact courses that should be required for an engineering degree is a work of great proportions and one that can never be finished, but if we can agree on the definite purpose of engineering education we can at least eliminate every thing that evidently does not promote that purpose. Further, we can eliminate from the general requirements such courses as are of value to only a small proportion of those of whom they are required, and substitute more thorough courses in such subjects as English, political economy and contracts, which are of direct use to everyone.

But after all, it is more important that subjects be studied properly than that the proper subjects be studied. Four years is a small percentage of a man's life and if, while in college, he learns where to look for information, how to classify that information, and the fundamental principles that should guide him; if he realizes that what were facts yesterday may be false to-day and that his own knowledge is infinitesimal; if he learns to attack his problems in a systematic, orderly manner and to consider all sides of a question, he will attain the highest position that his capacity and opportunities afford and we shall hear less about the shortcomings of the college graduate.

PART II.

PROCEEDINGS OF THE SOCIETY.

The following papers were presented and discussed at the Minneapolis meeting. Brief written contributions, if sent to the Secretary promptly and if approved by the Publication Committee, will be printed in an Appendix to Vol. XXI of the PROCEEDINGS now in press.

The paper by Professor E. C. Schmidt, which appeared in the June BULLETIN, pp. 690 to 700, will comprise pp. 77 to 88 of Vol. XXI of the PROCEEDINGS and will immediately precede the paper by Professor Richards.

IDEALS OF COLLEGE LABORATORY CONSTRUCTION.

By C. RUSS RICHARDS,

Professor of Mechanical Engineering, The University of Illinois.

It is, or it should be, the purpose and the function of the engineering laboratory to illuminate the work of the classroom through the verification of physical laws and the determination of the limitations of pure theory; to present to the student the several instruments of the engineer and to familiarize him with their use and care; to stimulate his practical instincts through the handling and testing of machinery of all kinds, and to develop in him some technique in the conduct of experimental investigations; and, finally, to encourage scientific research through which the extent of human knowledge may be increased.

If we accept these ideals of the functions of the engineering laboratory, it must be realized that the construction and equipment of such laboratories is a serious business, not to be undertaken hastily, or without careful consideration of the needs to be served, and it should be realized further, that those who are responsible for such work must be prepared to drop other interests and give their undivided attention to the project for a long period of time, for years if necessary.

An inspection of many of the engineering colleges of the country leads me to the belief that though many engineering laboratories have been built, few have been designed. Given adequate funds, anyone can erect buildings and buy machinery and other apparatus to be placed therein, but everyone will not, by this process, produce real laboratories approaching the highest ideals of service, convenience and adaptability.

Evolution of the Laboratory.

As a rule our engineering laboratories have been slowly developed from the most meager beginnings, often in quarters illy adapted for laboratory or any other purposes, and growing in this haphazard fashion made necessary by inadequate funds and lack of appreciation and interest on the part of college officials. Under such conditions of growth, there can be no adherence to definite plans of development, even when such plans have been prepared. It is small wonder, then, that we find so large a number of laboratories which are illy lighted, poorly ventilated and with few conveniences for work, containing a conglomeration of apparatus in various stages of decrepitude or obsolescence, placed without any apparent thought or system and presenting an appearance so unattractive that a student must indeed be an enthusiast if he receives any inspiration from the work done therein.

What Makes a Good Laboratory?

It is difficult, if not impossible, to define the differences between a good laboratory and a bad one. They are not alone in the building, although that is usually of primary importance, nor in the equipment, but rather in the evidence of systematic arrangement of apparatus and its preparation for experimental work, and in the painstaking and intelligent design of the innumerable details, both of building and equipment, which add so greatly to the convenient use of the laboratory. In other words, it is the evidences of the work of the man of ideas and of ideals which principally distinguishes the good from the mediocre in laboratory construction.

In the design of laboratory buildings it is unlikely that there will ever be a standard type which will be recognized as ideal under all conditions. The peculiar uses to which the building is to be put, local conditions of site and the personal idiosyncrasies of the designer will determine the style and arrangement of the structure. Ideals are evolved by the slow process of evolution and as yet we have made too little progress in the development of laboratory construction to fully realize what constitutes perfection.

Laboratory Architecture.

The art of the architect and of the architectural engineer has made wonderful advances during recent years and we have become accustomed now to the conveniently-designed and beautifully-finished buildings erected for all kinds of business and public purposes. It has been proved that the extensive use of marble, enameled brick or tile, and other expensive materials, which was at first thought to be an extravagance, is in reality a real economy due to decreased maintenance costs. These standards set by office- and business-building designs are rapidly influencing the design of buildings erected for other purposes, even in the industries. Factories are now built with the most careful attention to the details of lighting, heating, ventilation, and finish; many modern power houses are models of design in convenience and architectural beauty and finish. College buildings are now frequently built with reference to these modern standards, rather than with the idea of securing a maximum of room with a minimum of cost. It would seem, then, that it is not unreasonable to demand that engineering-laboratory buildings conform to the standards of excellence in exterior and interior design and finish now recognized. Without doubt the psychological and educational influences resulting from well-lighted, well-ventilated, well-designed, clean and attractive laboratories are worth many times the difference in cost between good and cheap types of construction. We can hardly expect to arouse a tremendous enthusiasm, either in the student or his instructor, for work which must be performed in dingy and dirty quarters. Where such conditions exist there is danger that invidious comparisons will be made between the work of the non-technical and the technical student which may handicap the larger development of the latter.

Ideal Laboratory Buildings.

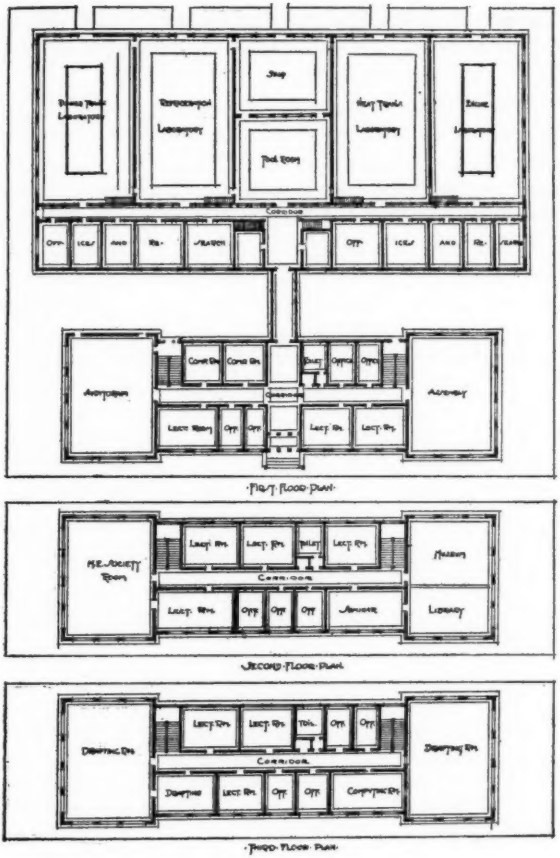
Wherever practicable engineering laboratories should, in my opinion, be one-story buildings with high basements, and with monitor-type roofs to provide proper ventilation and light.

The walls should preferably be of brick, faced on the interior with light buff-colored pressed brick with an enameled-brick wainscoting six or eight feet above the main floor level. The main floors should be of reinforced concrete, carried by steel beams and columns, designed for a live load of not less than three hundred pounds per square foot, well finished on the surface and painted with an approved cement floor paint to prevent the formation of cement dust and the absorption of oil. The roof trusses should be of steel with a light concrete roof supporting a covering of slate or tile. Spanning each room there should be a traveling crane of sufficient capacity to safely handle the apparatus installed.

With such floor construction as described, practically all of the machinery installed on the main floor will require no foundations to the ground. Hollow foundation walls may be needed for apparatus of unusual weight, or where excessive vibration results from the operation of a machine, but steam and gas engines of the usual laboratory sizes will need no extra support. All auxiliary apparatus, such as condensers, piping, etc., can be suitably located in the basement. To facilitate communication between the two floors, an open "well" may be constructed down the center of the main floor.

The width of the laboratory or succession of laboratories, if several be joined together as would normally be done, should rarely be less than sixty feet, unless special conditions demand another dimension. The length of the rooms or "bays" may be of any dimension and the building should be so located as to permit of ready expansion at one end.

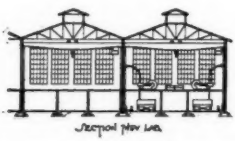
The window area provided should be as large as the style of construction will permit, some of the newly patented steel frames and sash with prism glass being probably best adapted to such buildings. It is rare that too much light is admitted and in most existing structures there is an altogether insufficient amount. Not only should all the daylight possible be admitted, but particular attention must be paid to the problem of artificial lighting to permit satisfactory work to



FIRST FLOOR PLAN.

SECOND FLOOR PLAN.

THIRD FLOOR PLAN.



SECTION NEW LAB.

SCHEME FOR PROPOSED MECHANICAL ENGINEERING BUILDINGS.

STUDY FOR A NEW LABORATORY FOR THE UNIVERSITY OF ILLINOIS.

be done on gloomy days or at night. Whatever system of lighting is adopted, it should give a uniform illumination of not less than three foot-candles at the floor level.

Since, ordinarily, large quantities of water are used in the laboratory, ample provisions for its handling and disposal must be made. If large volumes of water must be accurately measured, properly designed concrete flumes with weirs, or large measuring cisterns should be constructed as an integral part of the building. Conveniences for handling water in engine laboratories, for instance, are frequently overlooked in the original design of the building, and their later installation is apt to be unsatisfactory.

Adjoining each main laboratory there should be a sufficient number of comfortable offices and at least one standardizing laboratory for the testing and calibration of instruments. In addition there should be a number of small research laboratories where advanced students or members of the faculty may prosecute scientific investigations without the interference, and annoyances and disorder which result when such work must be undertaken in the main laboratory. The importance of such rooms is recognized in the design of chemical and physical laboratories, but so far scarcely at all in engineering laboratories.

Ideal Laboratory Equipment.

The equipment of engineering laboratories, while important, is comparatively of smaller importance at the start than the design and arrangement of the building, for mistakes in the purchase of equipment are less serious than the erection of a building illy adapted to laboratory purposes. Of necessity, the selection of equipment for undergraduate instruction must be along somewhat conventional lines, for certain general kinds of work are recognized as essential in the laboratory, and proper facilities for such work must be provided. While in the choice of such conventional apparatus there is an opportunity for the exercise of some individuality of judgment, it is the selection of specialized equipment that dis-

tinguishes one laboratory from another, and marks the personality of the man in charge.

All apparatus for undergraduate instruction should be of such size as to command the respectful attention of the student. A "four cat's power" engine or motor is perhaps sufficient for the instruction of the student in the motions of engine or motor testing, but such toys can hardly arouse his enthusiasm for or belief in the value of the work. In general all equipment installed should be of sufficient size to permit it to be adapted to graduate and research work, for it is only by such work that the highest ideals and the largest measure of usefulness of the engineering laboratory may be attained.

DISCUSSION OF PAPERS OF PROFESSORS SCHMIDT AND RICHARDS.

Dean C. M. Woodward: Will the authors, or Dean Goss, kindly tell us how they succeed in getting the money for these fine laboratories?

Dean W. F. M. Goss: The University of Illinois is interested in questions affecting the design and efficiency of railroad equipment because Illinois is a great railroad state. This development of a locomotive laboratory by its College of Engineering is to be looked upon merely as a response to a demand which arises from many parts of the state. The College has been doing what it can to train men for the manufacturing industries, for the public service, as municipal engineers, for expert service on structural work, and in many other departments of engineering activity. Why should not the state of Illinois be equally concerned in providing itself with facilities whereby it may train men for the transportation interests and why should it not do work which will contribute to advancement of our scientific knowledge of transportation problems? These questions have been asked and they find their answer, in part, in the upbuilding of these laboratories.

President Magruder: Will Dean Goss please tell us what, in round numbers, such a locomotive laboratory and railway mechanical engineering equipment cost?

Dean Goss: The cost of a laboratory may vary within wide limits. No statement that I can make regarding a specific solution of a laboratory problem should be accepted as an index to what some one might require to solve a similar problem, under other conditions. Twenty years ago, when I began the development of plans for testing locomotives at Purdue, I had set apart for my use the sum of $8,000. This was a large sum in those days to be spent upon a single piece of apparatus. I spent half of the sum allotted for the purchase of a locomotive, and the other for installing a plant. This plant, as you all know, has been very useful. In process of time, the original plant has been materially added to and the occurrence of a fire, which destroyed the original installation, opened the way for a new start. The Purdue testing plant, as it stands today, including the building and mechanical equipment, may fairly be valued at from $20,000 to $25,000. That plant represents what was thought to be desirable twenty years ago. Meantime, locomotives have been increased in their dimensions and power. In building a plant for the University of Illinois, we were required to provide for present day needs and to allow a margin for every emergency likely to arise in the near future. The Illinois traction dynamometer is of 125,000 pounds capacity. The Illinois plant provides a wheel base of about ninety feet. The complete plant has cost about $75,000.

As you know, I am particularly interested in this field of work. This fact and a sense of justice to my colleague, Professor Schmidt, leads me to say that I, personally, am not responsible for any of the details of design which appear in this plant. It is all Professor Edw. C. Schmidt's work from beginning to end, and the credit of having brought into existence so important an installation is entirely his.

Dean Woodward: I want to suggest another idea in reference to the use of such expensive apparatus as this and to ask if any provision is made for making the results of the investigations generally accessible. In the experiment stations and farms which the government maintains many valuable results are obtained and these are made available to all who

can utilize them. I should like to know to what extent the work of such a laboratory as that described is thought to be useful to the transportation interests generally. While the primary purpose of the laboratory is to train men, that work is individual and local. While you are training the students of the University of Illinois, to what extent are some of the results useful to the entire country?

Dean Goss: I am sure that a good deal of the success that the University of Illinois has had in securing money for the maintenance of its College of Engineering has grown out of a conviction that has become common among the people of the state, that the university's function is not merely that of teaching; that it owes a duty to science, and to the commercial and manufacturing interests, and that this duty cannot well be discharged by any other agency. The citizens of Illinois are looking not merely to the work of instruction as the return received from their investment in the University of Illinois. They expect the university to do its part in helping to move the world along. Our knowledge of locomotive performance has been increased tremendously during the past twenty years, through the presence of locomotive testing plants. And I think it was not an unhappy thing that such plants should have had their origin in a college. I have felt during the past two years that an important part of the scientific work of our College of Engineering is represented by this design, which Professor Schmidt has put before you. Suppose the plant had never been built, or suppose it only served as proving the value of such a plant? The fact that a new solution of an important problem has been found is entirely worth while. While the railroads of the country generally do not have locomotive testing plants today, the number will increase. We are assured as to the value of such a plant through the tremendous activities which the Pennsylvania Railroad Company has exercised in the maintenance of its plant at Altoona, now about ten years old. So it is that in the working out of the problems of a college, it becomes quite necessary, desirable and fair, that those who are responsible for the administration

should keep continually before those who give their support, a large view of the service which is to be rendered through the development of great problems.

Of course, there are sometimes people who object and say that it is possibly all right to help the small mechanic, or to help the small manufacturer, but why should the college attempt to help the railroads, which are able to take care of themselves. Why spend state money in solving problems of the great corporations? The answer is simple. Whatever really serves the interests of a great public service corporation must, in the end, contributes to the welfare of the people who are served by the corporation. The great corporation, under right management, is merely a servant of the people. In the process of time, whatever the college may do to improve locomotive practice, will help the man who travels, or who sends his freight by train.

Dean Woodward: I am delighted to have that statement made. I expected it from the University of Illinois, the institution over which President James presides. Although he is not an engineer, he must sympathize in good work, of such broad, altruistic character. In contrast to this I remember at one time visiting, as a specially-privileged guest, a testing tank in Glasgow, Scotland. Here models of the great liners were formed and studied in every detail. But the results were all kept secret.

President Magruder: Notwithstanding the circumstances outlined by Professor Woodward the professor of naval architecture at the University of Glasgow has just been knighted by the king for his services. I trust that we may have certain of our college professors and deans knighted sometime.

THE EDUCATIONAL SIDE OF ENGINEERING DRAWING.

BY THOS. E. FRENCH,

Professor of Engineering Drawing, The Ohio State University.

I am not sure that this title is self-explanatory. It suggested itself from the wide diversity in the present methods of teaching drawing, and the rather general feeling of unrest, as indicated partially by the abnormal number of text-books on drawing, and particularly on descriptive geometry, that have been appearing recently. (A prominent publisher told me last year that he was thinking of getting up a printed form for the rejection of descriptive geometries!) The prevailing tone of defense or explanation in the introductions of these books echoes in a way the lack of satisfaction in some of the schools and a desire to do something for a change. To say that drawing is a fundamental subject in a technical school seems so trite as to be needless. It is of course recognized as a subject necessary for the student as preliminary to all his engineering work.

Drawing as a Language.

The analogy between drawing and language is often referred to. I prefer to go farther in saying that drawing, as a mode of thought expression, *is* a real and complete written language, with its orthography, its grammar and its style, its idioms and abbreviations; and that in teaching it we are not only preparing the student in a subject needed in his course but, from the very nature of it, have in our hands an exceptional cultural subject for strengthening the power and habit of exact thinking, that most difficult of all habits to fix, and for training the constructive imagination, the perceptive ability which enables one to think in three dimensions, to

visualize quickly and accurately, to build up a clear mental image. This ability, with the power of recording the visualized impression and expressing it to others, is a requirement absolutely necessary for the young designer, and its study will develop a part of his mind which has previously had practically no exercise.

As one has said, it is "the power and habit of observing accurately that marks one of the fundamental differences between the incapable man and the man of power"—and in this connection I regard memory drawing as a valuable exercise.

The Need and Value of Drawing.

As to the need of drawing, let me quote from an address of a few years ago by President Eliot.

> "I have recently examined all the courses offered by the University, and I find but one (the course of theology) in which a knowledge of drawing would not be of immediate value (and even there I think it might help in some cases)."
>
> "The power to draw is greatly needed in all the courses, and absolutely indispensible in some of them. A very large proportion of studies now train the memory, a very small proportion train the power to see straight and do straight, which is the basis of industrial skill."

As to the value of drawing, to quote again, this time from Dean Shaler:

> "The value of drawing in all departments of science, not only as a language, but as a discipline of the mind, can hardly be overestimated. Many students entering Harvard University can think in one dimension, some few in two dimensions, but those who can think in three dimensions are exceedingly rare."

With this conception of the subject, that it is at once the foundation upon which all designing is based, and preëminent in its value for mental discipline and training in space intuition, engineering drawing becomes, with the possible exception of mathematics, the most important single branch of study in a technical school.

The emphasis of this discussion is directed to calling attention to the danger that the course in engineering drawing may be regarded as only for the purpose of teaching how to

draw. That some school authorities do not regard its higher value and possibilities but think that drawing means only learning to hold a T-square and make lines with a ruling pen, is indicated by the subordinate position often given to the department, in placing it in the care of inexperienced and low-salaried instructors, or often carrying it as an annex to another department.

Older Methods for Teaching Drawing.

Many of you remember the old courses in drawing, when there were fewer books and Warren was the standard. They were good old books, full of theory. The student of those days could project anything anywhere, but he could not make much of a working drawing. Afterwards Faunce's well-known book came in. The plates of this little old classic are not worn out yet, and although it has been obsolete for twenty years the book is still being sold on its record.

You will recall the amount of time spent on revolutions, and "shades and shadows," and the laborious tinting of cylinders and spheres and niches, a relic that persisted in the schools long after the necessity for it had passed. The schools, we all realize, are often somewhat behind current engineering practice. But in drawing they kept persistently behind. After blue-printing came in they continued the tinting and pricking and making fine-line tracings. You remember the transition from the first to the third angle, and the fierceness of the wars that were waged in the drafting rooms, and back and forth in the *American Machinist*. It was mainly the school-trained men vainly defending the system they had learned, against the opinions and experience of the self-made shop men. The late Professor S. W. Robinson, whose memory we all revere, was one of the earliest advocates of the third angle, but the first angle was still taught in his university, as well as in many others, for years longer than it should have been, in spite of these pioneer progressives.

In those old days there was however something of a recognized standard orthodox method of teaching drawing, en-

cumbered as it was by the French adaptations and archaic methods. In the reaction against what is seen now to have been an excessive amount of theory, and with the attempt if not to govern at least to follow commercial practice, there has been so much variance of opinion that I believe it can be said that there is at the present time a greater diversity of method in the teaching of drawing than in any other branch in a technical school.

Educational Value of Instruction in Drawing.

It is in the present-day demand for the "practical" that there lies some of the danger of losing sight of the educational value of a subject that has in it the greatest combination of possibilities for the correlation of theory and practice.

In trying to show him in the quickest possible time how to make a working drawing, and how to place dimensions and letter a title, we are *apt* to miss the opportunity of training in the student the power of space conception, and clear thinking.

His mathematics is given him for subsequent use, *and* for exercise in reasoning. This training of the perceptive ability and imagination in drawing may seem apart from pure reasoning, yet if you will agree that the foundation of right reasoning is accurate perception, it ought greatly to strengthen the power of logical demonstration.

You will recall what Young says in his "Teaching of Mathematics."

> "Mathematics makes constant demands upon the imagination, calls for picturing in space (of one, two or three dimensions) and no considerable success can be attained without a growing ability to imagine all the various possibilities of a given case."

I trust I am not misunderstood—all of this *can* be taught while he is making his working drawing if we will *do* it.

I am not advocating pure theory—as in Gauss' remark—you recall Gauss" famous toast—"I drink to pure mathematics, the only science which has never been defiled by practical application."

Present Methods of Instruction in Drawing.

Disregarding the copying courses, the giving of a series of plates to be copied by the student, which with the conception of drawing as a language to be studied and taught in the same way as any other language, does little more, as has been said elsewhere, aside from showing certain standards of execution, than copying paragraphs from a German book would do in beginning the study of the German language, disregarding these and the interminable geometrical courses, the methods now in use, with all their variations, may be divided into two general classes:

1. Those which begin with the theory of the point, line and plane, and progress to the solid.

2. Those which begin with the solid, and afterwards take up the anaylsis of lines and surfaces.

The Synthetic Method.

Considering the first division, all of the older books on drawing from Binns to Faunce began with the projection and revolution of the point, and a few of the later books still adhere to this method. The schools using this method, however, generally begin immediately with a text-book on descriptive geometry. This system was ably defended in a paper read at the Cleveland meeting of this society.

This synthetic method, as it might be called, seems logical, but experience has shown that the student has much difficulty in understanding it clearly. He starts in with a hazy idea of what it is all about, and often never comes to a clear realization of its purpose or its beauty. (We all know the not infrequent case of the good student who "flunks it dead" the first time, and gets his vision with startling suddenness on the "second trip.") In a subject which depends wholly on clearness of perception, and whose value is entirely lost if the mental picture is confused, the possibility of this condition is most unfortunate. It is this failure in comprehension on the part of the student that gives descriptive geometry its traditional bad reputation.

And when after all this elaborate theory he finds, as he believes, that it was only intended as preparation for the drawing of some simple objects, and developments, similar to those he may have made in the high school, it is little wonder that he loses his respect for it.

When we consider that many men after leaving college fail to appreciate the perceptive development and mental training that they have unconsciously received from their study of descriptive geometry, how much more is it true that the young student with his undeveloped mind, thrown head-first into this new subject, cannot realize that it has any value, cultural or practical; and accepting the principle that the highest benefit cannot be gained from any study without the interest that comes from involuntary attention, the full benefit of descriptive geometry cannot be attained from this class except in isolated cases.

The Natural Method.

While there is of course more than one route to a given destination, the second method, taking up the explanation and practice of orthographic projection by using the solid, practical mechanical drawing if you please to call it, and afterward descriptive geometry as the term is generally understood, not only has the support of abundant proof in experience, but can be defended psychologically as well. As variations, some teachers begin both subjects at once, as at Annapolis; some avoid the use of the term descriptive geometry altogether. Some have a beginning term consisting entirely of free-hand sketching. Dean Anthony has done more than any one else to show that projection drawing can be taught more easily by beginning with the solid. Without question the student gets his space intuition more clearly by handling concrete forms than by at once attempting to imagine lines and points revolving in space.

This beginning course should include both orthographic projection and the various pictorial projections, and the objects chosen should be real machine or structural parts so far as

practicable. It may go well into intersections and developments including triangulation. These problems given as drawing are worked readily and with interest. The same figures when given as special cases of descriptive geometry problems are found to be very hard.

FIG. 1.

Lettering ought to be taken up at the first of the course, freehand single stroke lettering is meant, and continued in short intensive periods through the term. But another relic, the mechanical caricatures of letters made with compass and ruling pen, should be scrapped in the same 'hell-box' that already contains the fancy titles and other typographical flourishes and curiosities of our forefathers (see Fig. 1).

ENGINEERING DRAWING.

While it is really descriptive geometry, I prefer to call all this "engineering drawing"—engineering drawing rather than "mechanical drawing." The term mechanical drawing is an unfortunate misnomer, which may mean either drawing with mathematical instruments or the drawing of mechanical things. Engineering drawing covers the whole field of technical drawing; and the important part of it *could* be taught with only a pencil and a pad of coördinate paper.

It would seem entirely beyond the scope of this topic to attempt to outline a course in drawing. It may however not be out of place to offer a few suggestions, perhaps more or less disconnected, that have to do with teaching drawing in a way to use the pedagogical opportunities.

In the first place there should be an explanation of the

purpose of the subject, calculated to arouse interest and enthusiasm (such a suggestion as this will be almost resented by the good teacher in any subject, but I have seen so many courses started with no preliminary description of aims or reasons or what was coming and why, that I am constrained to let it stand).

The good teacher will follow this later with descriptions of shop methods as they apply and of drafting room methods and organization and management.

There should be insistence on good form in the handling of the drawing instruments and on high standard of execution of the finished drawings. It is a *graphic* language and the beginner must have skill in its recording. While not the largest proportion of graduates start as draftsmen yet they must know good work from real experience with it, and while it should be explained that the execution, the making of drawings, with whatever labor and neatness and care, is not the whole purpose but, rather, incidental, the argument of the student who says "I never expect to work in a drafting room" should be met gently but firmly. He will soon find that a good drawing can be made just as quickly as a poor one.

After accuracy comes speed. Time limits carefully estimated and set, so that it is considered derogatory rather than meritorious to be putting in extra time in the drawing room. As "faith without works," so is accuracy without speed. Instead of the old extensive course in geometrical drawing there should be no geometrical figures except such as a draftsman uses. I would trace most of the plates on cloth instead of inking and require both pencil drawing and tracings. The common beginner's fallacy that careless pencilling can be corrected in inking is thus destroyed. There are many principles whose application can be worked without making finished plates, by using the "study sheet" method, working the problems in pencil only on note book sheets. Much time may be saved by giving the printed problem ready for solution. In our own case this manifolding is done on the neostyle.

Value of the Recitation in the Drawing Course.

The time spent on the blackboard recitation, say one hour per week, is good investment. It is in these recitations that the first exercise in writing the language and reading the language may be had. It has been our practice to begin at once in working up the visualizing ability by such methods, the instructor making the pictorial view of an object, building it up or cutting it up, the students working up the three views. They really enjoy their own introspection. This is followed by incomplete views, drawing from description, etc. Comparatively early in the course isometric and oblique, with special attention to the latter, should be taken up, first for their own sake, but more particularly for their use in translating. As soon as they are handled readily the process above is reversed and the instructor carries through the series in "orthographic" while the students interpret or translate them by sketching, in some pictorial form (see Fig. 2).

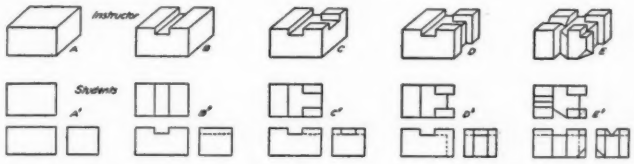


Fig. 2.

This practice has been found to be of great value. It is followed up by giving commercial blue prints from which certain parts may be assigned to be read. Details may be picked out from assembly drawings and illustrated. Difficult and puzzling shapes can by this time be deciphered; and during all these reading exercises the value of a ready ability to sketch pictorially is being unconsciously but indelibly impressed.

Training in Visualizing Forms.

Getting back to orthographic projection, models may be introduced and dimensioned sketches made. I believe in the

judicious use of models. They aid in visualizing not only shape but size. The first practical experience of nearly all young draftsmen is the same. After making the half-size or quarter-size drawing of a piece they are surprised at first sight of the casting in seeing how big it is.

The student should be able to look at the drawing and see the object. He should also be able to look at the object and see the drawing, *i. e.*, to decide quickly what views would best represent it. There should be much sketching and working drawings. In these he gets the application of all the principles. He now begins to appreciate "style" in the language, not in the execution but in the composition. Some drawings have all the information but are hard to read, some are redundant and tautological, some may even have split infinitives in the dimensions!

In developments and intersections, which have been preceded by auxiliary projections and the true length of a line, the classification of surfaces can be referred to with profit, and as has already been mentioned this work may be carried on into problems such as are often given as "special cases" toward the end of the descriptive course.

With a preparation such as this, and the consequent power of reading description from lines, descriptive geometry if introduced now becomes real and fascinating. It will be appreciated for its own beauty and for its aid in solving problems whose difficulty is now recognized and whose applications are understood.

In conclusion let me contend for a better recognition of the general department of engineering drawing, including descriptive geometry. Let it be preferably a separate department, manned by a corps of efficient, experienced, well paid instructors. I believe in the rule that all drawing instructors must have had practical experience on the board, not primarily for the effect on the student, with whom the respect for practice is so marked that it often even exaggerates the real value, but principally for the instructor's view point; and it requires more than the $600 or $800 minimum to find men with the

teacher's instinct and bring them from commercial work. These are difficult subjects to teach. One of the leading mathematics men of the country has said that descriptive geometry is the hardest known mathematical subject to teach well. The reason is of course understood as being on account of the wide variation in imaginative ability among students of the same mental capacity. Some have strong powers of visualization, some are almost destitute of mental imagery (as you remember Galton found his men of science to be). I have sometimes said that it takes five years to make a descriptive-geometry teacher.

Finally, let us have drawing taught well and understandingly, for its own sake, for the sake of the subjects following, and for the students' sake, for whom, with the power it awakens, it really becomes drawing in relation to life.

DISCUSSION.

Professor F. G. Higbee: I remember quite well the paper to which Professor French refers and also the humorous testimony which both Dean Benjamin and Dean Kent gave at the time it was read. Dean Benjamin said that he had been a practicing draftsman several years before he heard about descriptive geometry and that after he went to college he was able to find out what a hard subject it was; Dean Kent gave practically the same testimony. At that time these men felt that drawing and descriptive geometry were so closely related that they might well be taught as one subject—as drawing.

In my own teaching I have been confronted with the problem of the order in which drawing and descriptive geometry should be taught. And in order to reach a conclusion based upon more than mere opinion I have been experimenting for eight years with a number of arrangements and combinations which I hoped would settle the matter in my own mind. As a result of this just now I believe—at least as far as my own work is concerned—that it is better to give a complete course in engineering drawing first and follow it with a course in descriptive geometry. I have tried it this way and

in other ways and so far as the order affects students I can see little difference,—one way seems to work as well as the other,—but, in spite of this and of the fact that I once went on record as favoring descriptive geometry as the first course, I think there are some advantages in having the course in drawing taught before the course in descriptive geometry. Students at least get a reading knowledge of the language in which descriptive geometry is written and they learn to visualize to a certain extent.

The use of models is as important in descriptive geometry as it is in drawing. For drawing models I use parts of machines of good design, wrenches, valves, etc., and in descriptive geometry I encourage the students to build up models of their problems from their triangles, pieces of cardboard, pins, or whatever materials may be convenient. This assists them to *see* the problem as mere lines on flat paper can not. I recall an experience I had with one plodding and painstaking student whom I found working away underneath his drawing table with his T-square and triangles. I asked him what he was doing there and he replied: "Professor, I am in my third quadrant."

Draftsmen are inclined to look upon descriptive geometry as something of little use, and I think this is the result of teaching it as *geometry* rather than as drawing. Such men may know all they need to about the subject but not by that name. As an illustration of this a problem which appeared recently in a well-known technical journal is to the point. The problem consisted in finding the angle for a fitting which was to be a part of the connection between two pipes lying at different elevations. The writer of the article gave a neat demonstration of the ancient and honorable problem "To find the angle between two intersecting lines" and concluded with the astonishing assertion that "this will be found a much simpler method of solving this problem than that found in texts on descriptive geometry!"

Mr. J. S. Thompson: Will Professor French please give his opinion as whether it is desirable to have the drawing work

carried through to a considerable distance in the course which is in the hands of the drawing department, or split up and put into the hands of the separate departments?

Professor French: Drawing is a language and the different departments use that language in their own work. It may require a year and a half or, perhaps, two years in the drawing department, depending upon schedule and number of hours, to learn it but the students may at the same time be using in other departments the language they are learning. I think, however, that they should have training in the general department until they know it thoroughly in all its different expressions, and are able to use it. The "language" part of it should not be taught in the separate departments. When they apply it in special departments the students should have the language so thoroughly that all of their thoughts will be concentrated on what they are trying to express.

Professor W. H. Kirchner: I had one experience during the last two years in the line of lettering which is unique. We have at the University a school for training nurses, and it was found in the administration of the hospital that it would be a decided advantage for the young women in training for nurses to take a little work in practical engineering lettering or some slight modification of it. They decided that the bed-side sheets, the hospital reports and so on which were written in by the different nurses at different periods would present a much more uniform and acceptable appearance, if they had had training in the elements of simple single-stroke free-hand lettering. The course which these young women take is much congested, all of the morning hours being occupied with the various lectures and other duties so that I could not devote much time to them. The first year I was obliged to take them for one afternoon, two hours at a time. During each period, I found that their work showed improvement and progress for the first twenty minutes, but during the next half hour, unless they were very much rested, it deteriorated. It seems, therefore, that lettering should be done in frequent short exercises, for classes of both sexes.

SHOPWORK FOR ENGINEERING STUDENTS AT THE UNIVERSITY OF MINNESOTA.

By J. V. MARTENIS,

Asst. Professor of Mechanical Engineering, University of Minnesota,

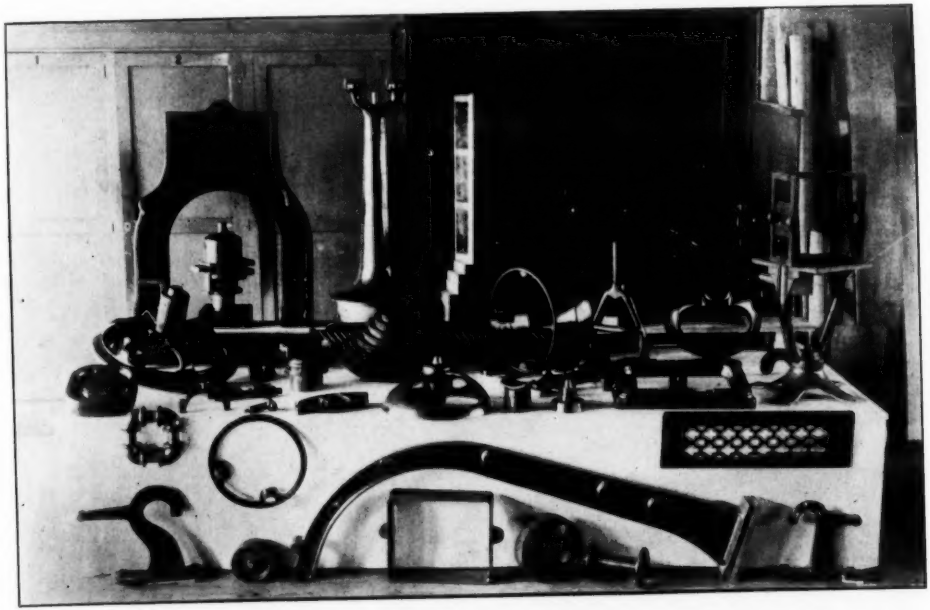
AND W. H. RICHARDS,

Instructor in Woodworking, University of Minnesota.

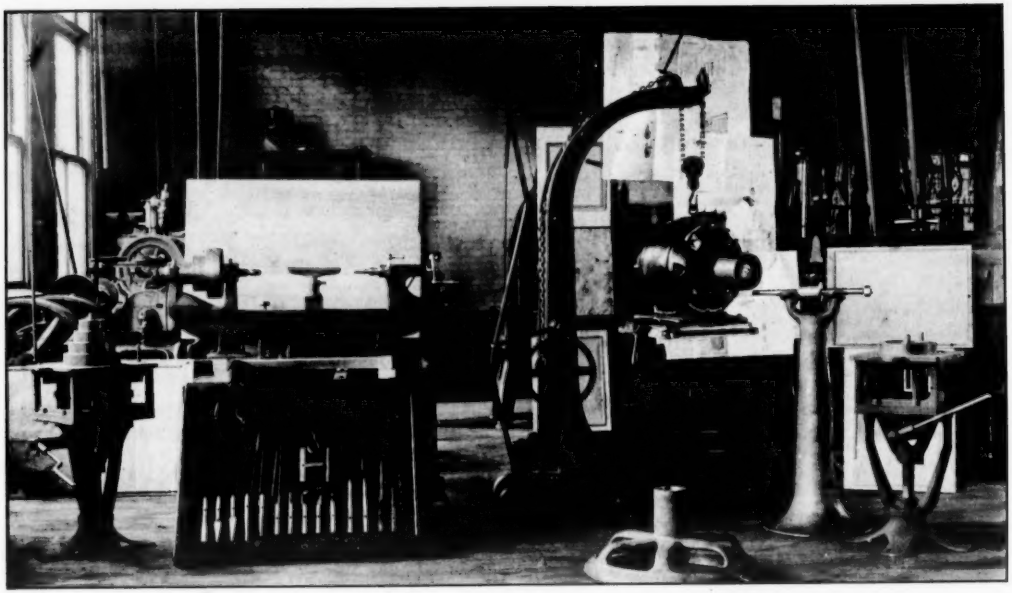
The fundamental object of shop work, as it should be administered, is to teach the student who has had little or no preliminary training in the manipulation of shop tools, the correct use of those tools, and at the same time the possibilities and limitations of the various tools which are to be found in the up-to-date shop. The student should also learn shop methods and the coöperation of various lines of shop work. We do not expect, nor do we desire to turn out expert artisans, for the average college curriculum cannot allow a sufficient time to produce such results. It is important, however, and upon that great stress should be laid, that the attainment of a fair degree of coöperation of mind and hand and the ability to lay out work should be included in the aim of instruction.

Two Important Secondary Functions of Shopwork.

The student should learn first to observe the rules enforced in the shops, especially those relative to the use of machines. It is most important that the student should learn to exercise great care in the use of all high-speed machines, not only to guard against accidents to himself but also to his associates, as machines having exposed moving parts are a menace to all and are especially dangerous to the careless ones. All machines should have protective devices installed where necessary, and a course of lectures on shop safety devices should be given early in the student's shop career.



University of Minnesota — Exhibit of Patterns.



University of Minnesota — Exhibit of Machine-shop Products.

The shop furnishes a splendid school of experience for the student in engineering, because it helps him to determine in a measure what his future vocation shall be. Taking the students as they present themselves, it is found that some evince especial adaptability to shop instruction. On the other hand, others seem utterly unable to acquire the ability to use shop tools with any degree of facility. In many instances a student's shop experience will indicate whether his vocation be rightly chosen or not. It is apparent that if you assume that inability to use shop tools is a fair index of a mistaken calling, when such a condition arises, it may be useful in calling attention to the error early and thus save serious loss of the student's time. In this connection, it should be urged strongly upon those who prepare the student for his course in engineering, that the preparation should be such that he may be able to read and understand simple shop drawings.

Administration of Shop Courses.

The order in which the various lines of shop work should be administered is open to question. We have considered it advisable to have the student take his carpentry and pattern work first, followed by forge, foundry and machine work. There would seem to be an argument in favor of such an arrangement inasmuch as the class of work performed in the wood shop lends itself admirably to manual dexterity and can have much to do in forming correct habits of procedure and also in instilling in the student a correct sense of proportion and of pride in the character of his work. Outside of these considerations there are certain factors entering into the arrangement of shop courses which must adapt themselves to the administration of the various lines of work.

The utility of the shop products should always be borne in mind. It is most profitable to minimize the number of strictly exercise pieces. In the wood shop the student is instructed to grasp the fundamentals of the use of wood-working tools and of wood forming. Then he is given work of a practical nature, being assigned work which may be used in construction in

some part of the shop, or patterns for pieces which are required to the further development of the equipment. We try thus to give the student the commercial sense in his shop work. The patterns are used in the foundry for the production of castings which are later machined and used in the construction of shop machines and equipment. The value of this method lies in its tendency to increase the interest of the student in the work; it also cuts down the cost of maintenance and of obtaining machines for the shops.

The time devoted to the wood work is about equally divided between carpentry and pattern work, namely seventy-two hours in each. The time is increased in the foundry to one hundred and eight hours, in which limited period each student is given some training in floor and machine molding, core making and brass casting. One lecture per week is included.

In the forge work the same principles apply. Beyond the necessary practice in welding, the pieces produced are utilized in the shops, so that there is little scrap except spoiled pieces. Bolts and other forged pieces furnish good exercises for students in the machine shop. Seventy-two hours are devoted to work in the forge shop, including one lecture per week.

Much greater time is given to the machine shop. Three hundred and sixty hours are devoted to this work for the mechanical engineering student, which includes one lecture per week for a period of a year and a half. The lectures during the last half-year relate particularly to automobile construction. The entire course in shop work for the mechanical engineering student requires a total of seven hundred and two hours. The students in electrical engineering have the same course with the exception of the last semester in the junior year, in which they have only four hours per week and no lecture, whereas the mechanicals have six hours and the lectures on automobile and gas-engine construction.

Advanced Shop Exercises.

After a sufficient preliminary training in the use of machines and tools in the machine shop, the work there tends

largely to increased efficiency. The students build lathes for the wood shop, motors for the various shops, and other equipment, and in addition construct machine and kinematic models. The work is done from their own detailed drawings. To further accentuate the commercial side of the work the students have time cards upon which they "ring in and out," using the time clock. In conjunction with the practice work, a number of shop trips are taken, and in order to train the faculties and powers of observation, detailed reports are made.

Beginning with the next collegiate year, it is proposed that these reports shall have a twofold value as each will be examined and criticized from a technical viewpoint by the shop instructors, and its language and composition will be reviewed by the Department of Rhetoric. It is expected that this arrangement will be productive of greater facility and care in the arrangement and construction of the report.

Conclusions.

Shopwork is valuable in teaching the student common engineering terms and phraseology, such knowledge rendering the following technical courses more intelligible and interesting.

It has been found that competition is a great incentive to increased interest and productiveness. It is especially true where the work is of such a character that groups may be assigned to complete equivalent tasks.

In assigning a group of students to a task it is advisable to allow the group to select its own captain, for by so doing it will exert itself to a maximum in order to produce the best results.

Discussion.

Dean C. M. Woodward: Do these students come from all over the state, from St. Paul and Minneapolis, the farming and other districts?

Mr. Richards: About sixty per cent are from outside of the "twin cities," largely from Minnesota. In some cases we do get stragglers, as you might term them, from elsewhere.

Dean Woodward: Do you give credit for the instruction in wood-work and metal-work which they have had in their preparatory schools?

Mr. Richards: We do providing it will meet with our requirements. If a boy can show he is capable of doing work which is the equivalent of our requirements we are very glad to give him full credit for it.

Dean Woodward: The reason that I ask is that in some communities, as in St. Louis, nearly all of the boys who enter engineering schools have had four years of training in shop work in the high schools, or in the manual training schools. Of course each one has constructed a project in the shop, sometimes jointly, and sometimes individually. When they come into the university where they have a shop with a totally different kind of fittings, they can enter at once upon a very much higher stage of work and deal with problems suited to college students.

Professor Martenis: Some of the students who present work for credit in our shop have rather a limited experience. The work for which they wish credit may consist of work on some particular class of machine. As our exercises comprise lathe work, planer work, milling-machine work, in fact work on all machines that we have, the credit given to a person skilled on any machine would be for work on that machine only.

Professor B. L. Newkirk: Do you not find that you very seldom give credit for any more than part of the freshman work?

Professor Martenis: Very rarely, unless the student be par ticularly well prepared.

President Magruder: I would like to ask Professor Woodward if a boy who has been graduated at one of the manual training high schools, such as the McKinley in St. Louis, goes to Washington University and offers his shop work at the McKinley High School for credit, how much credit is given him?

Dean Woodward: He gets no university credit because the university work is on a different plane.

President Magruder: Then as I understand, you require a certain amount of shop work equivalent to that given in the McKinley High School for admission?

Dean Woodward: Yes, the students must either have it, or they must get it.

President Magruder: If they must get it, where do they get it, if they have not had it when they apply for admission to the university?

Dean Woodward: There are a dozen places in the city, or they can do it in the university shop in extra hours.

President Magruder: Is the course so arranged that they can get four years of manual high school shop work in the university in extra hours?

Dean Woodward: No, the work that they do in the manual training school is not simply to prepare them for the shops of the university. They do any kind of work in the shops of the schools for educational work. That particular work is not required in the university at all. Every boy in the manual training high school goes through the whole course, involving drawing, art work, and work in metals, in moulding, in pattern work, in forge work, and in machine work, but they do not undertake to do any practical work. The work which they are given in the university shops, if they have not had instruction in manual training, is of an elementary nature to prepare them for the advanced work, but it does not exactly duplicate the work which they should, preferably, have had in the high school.

Professor P. F. Walker: Touching on this point of credit for school work I would say that at Kansas we give credit for work done in the Kansas City Manual Training School somewhat as has been indicated as the practice in Minnesota. There are a few other high-grade schools from which we draw, boys from which may receive a certain amount of credit also. This may amount to the whole of the freshman work in extreme cases, although we are placing our freshman work on a new basis so that we probably cannot hereafter give them credit for all of it. Such work as forging, however, can be easily learned in high schools.

We are doing something in the way of making tools, and small machines also. Our shop, in fact, is coming to have something of a commercial side to it. We have employed a mechanician, a workman of high grade, who is making the finer grades of scientific instruments, and we have a journeyman foundryman who puts in his time as an employee turning out work and at the same time does some instructional work. Thus, as our students become more proficient in the machine shop, we are in a position to put them on such work as making parts for lathes. We find that this is just as good educational work as if all their time were spent upon formal exercises. We find that we can turn out excellent work in this way and the students have a greater interest in it. We have a special ruling from the state administration which permits us to dispose of some of our product on the market.

Professor J. A. Hunter: I would like to ask if any of the new students are allowed to pass up any or all of the shop work on examination. We have coming to us men who have served apprenticeship courses in machine shops, or in woodworking and turning. We allow them to pass a limited examination in that part of the work, and then require them to devote the time gained by that to other engineering courses, perhaps in the drawing room. Is that the practice here?

Professor Martenis: Practically so. If a student is proficient in any particular line of shop work, he is given credit for that work, but he must demonstrate his knowledge of the work before he can be given credit for it. While speaking, I would call attention to another feature of our shop work, namely, the gaining by the student of a sufficient amount of shop practice to enable him to work up apparatus that he may need to use in connection with his thesis work. As students frequently carry on lines of investigation it is necessary for each to construct his own apparatus. Shop training helps him wonderfully in doing this.

Dean C. H. Crouch: Do you have journeymen mechanics working in the shops at Minnesota?

Mr. Richards: We have a mechanician to assist in the up-

keep of the equipment, but not to take part in the manufacturing work. That is entirely student work.

Professor Hunter: I was interested in the idea of having the student do all of the work here, because I have seen shops that were supposed to be school shops, in which the students got the "fag end," while the mechanics did the best part of the work. To return to the matter of advance credit, I believe that credit should be given for equivalent work wherever done.

Professor Walker: As Professor Hunter suggests, at the University of Kansas we take men from the shops on the same basis that we would take a student and give them advanced standing in almost any course for equivalent work. In case of an applicant presenting shop work for advanced credit we simply put him through some sort of examination to determine his ability before granting the shop credit.

Professor F. G. Higbee: One point in connection with this work has been touched upon which might be amplified, namely, the connection between drawing and shop work. There is a tendency for these to spread apart rather than to get together. The instructor in drawing thinks that it is the business of the shop instructor to teach the reading of drawings, while, naturally, the shop instructor believes it to be the duty of the drawing teacher to do it. At Minnesota, where do the students learn to read drawings?

Professor Martenis: In answer to this I will say that the students are assigned some certain machine to build. First they are required to get out the drawings and the details for it. The drawings are inspected and passed over to the shops where they go through one shop after another. The production of kinematic models accompanies the work in kinematics. The students turn out the drawings in devising the machine, and then the drawings are delivered to the shop men. We prefer to have the work done by the students who get out the designs, because they naturally take the most interest in the production of their own models.

Dean Woodward: I would like to ask what meaning you

attach to the word "design." You say "they design a machine," or they design something else. Does this mean merely making the drawing, or copying the drawing from some other machine, or copying the dimensions, or guessing at things, or is it really designing?

Professor Martenis: As we used it, the word "design" must not be taken too technically. The work itself is planned out as soon as the student gets a proper conception of what is to be accomplished. Of course the whole design evolves itself from the discussions between the students and instructor. The student is instructed along definite paths about the best practice to be used in connection with the devising of a particular machine and, as he gets the correct idea, he works out the details so that they will be available for shop use.

Professor Hunter: I wish to ask another question, one in regard to the supplementary reading mentioned in the paper. I have tried several different methods for conducting this reading work. One was to require certain pamphlets or books to be read at the student's own will. Another, which I am now using, is to have the readings assigned, to hold quizzes at definite intervals, and to grade on these exactly as is done in recitations. I would like to know if there is a better plan for carrying on this reading?

Professor Martenis: At Minnesota there is collateral reading demanded in connection with the shop work. That is particularly true in connection with the economic side of the work, which is not always fully covered in the recitation or lecture courses. For example, certain phases of foundry work are taken up by reading assignments in the current periodicals and possibly in a standard book on foundry practice. By such means the student is supposed to gain this knowledge outside of his regular class work.

Professor W. H. Meeker: This is one of the lines of work under my charge at the Iowa State College, where we have our courses arranged somewhat differently to fit our conditions. We start our freshmen at forge work followed by foundry work in the second term. The first term of the sophomore

year is given up to pattern making and the first half of the second term to advanced pattern making. The latter half of the second semester is occupied with steam-fitting and plumbing. The three terms following the sophomore year are given up to machine-shop work. There are two reasons for this arrangement. First, we have found that a student who has done some foundry work takes hold of pattern making with more interest and makes better progress in it. Some may wonder why we start our wood-working with pattern making. As Professor Woodward has brought out, a great many manual training schools of our state and others are now giving courses in manual training which includes bench work, carving, joinery and wood turning. When the graduates of these schools came to us we were obliged to give them credits or else start them in an advanced line of work. We had so many such cases that we finally decided to drop the bench work and turning and start with pattern making. While some of our students have not had manual training we find that we can teach the principles of joinery and wood turning along with the pattern making. In the second place, the reading of drawings for forge work is very simple, while the foundry requires no ability in reading drawings. When a student reaches his sophomore year he has had the drawing of his freshman year and is much better fitted to take hold of pattern making and to read accurately the drawings from which he must work.

I am also much interested in the giving of lectures in connection with the shop work. Professor Martenis states that a series of lectures is given with the course in machine-shop work, and I would inquire if he is also giving lectures in connection with the forge and foundry work, and other courses. It seems to me that, if pattern making is given first, it is almost necessary to have a course of lectures in order to tie it and the foundry work together. I would ask also, if Professor Martenis uses the same shop instructors to give the lectures and the shop instruction. We try to give the technical and theoretical work in the class-room, depending upon

the instructor to give only the work for which he is best fitted. We have not had very good success with the lecture system with shop classes. We find a few men who are interested but the larger part are not. We try to keep our shop sections so small that a student gets personal attention from the instructor. He thus has an individual lecture, as it were. This puts more work upon the instructor, but I believe that the results secured warrant the time and effort.

Professor Martenis: In connection with our shop work, we give a course of lectures. Each lecture deals particularly with the work which is under way at that particular time. There was a time when one instructor gave the lecture and another the shop work, but I believe that it is a better policy for the instructor who administers the shop work to give the lecture, to produce better coördination. The numbers that we have in the sections at times run quite high and it does entail extra work on the instructor to give the individual student the personal attention which he should demand, but the work seems to be given in a perfectly satisfactory manner.

Dean Woodward: Do you dignify the demonstration of a process to the class by the name of a lecture?

Professor Martenis: It may be a lecture, or it may be a recitation. We have certain text-books available so that the exercise can be given in the form of a recitation if desired.

Dean Woodward: Suppose that the instructor was going to teach a student class of thirty or forty how to make a weld. Would they arrange themselves around his anvil and near his fire and listen to him and watch him as he does the work, explaining every step. Would you call that a lecture?

Professor Martenis: No, that would properly be termed a demonstration. A lecture is given in the recitation room, where the student has only certain essential parts of the work for his immediate consideration.

Professor Kirchner: I would like to point out that these classes are arranged in the same sections for book and shop work. Some of you might get the impression that all of the sections are thrown together for a general lecture, but that is not the case.

Dean Crouch: It has always seemed to me that foundry work should come first as the student pursues his pattern work more intelligently if he has worked in the foundry and knows how each piece must be molded to get it out of the sand. Prior to last year the course was arranged in that way at the University of North Dakota. Last year it was decided to put all engineering students into one freshman class, as foundry work is not as necessary for the civil engineer as joinery and forging. My own opinion, however, is that the former arrangement is better.

Professor Flather: Responding to the remarks of Dean Crouch I would say that it does not make a particle of difference whether the pattern or the foundry work is given first. If one is given first, the students are better in the other.

Professor Kirchner: I would second Professor Flather's remarks. From an observation period of eighteen years I have concluded that it makes very little difference which one is given first.

Professor Meeker: Professor Martenis brought out the point at some men do not seem to take naturally to shop work or drawing and in some cases these men were discouraged from going on with the course, on the inference that they would not make successful engineers. I have reached the point where I am extremely cautious about drawing such a conclusion. One of the most careless men who ever went through our college shop, who was, in fact, so careless and did such crude work that the instructor shivered when he came in, realizing that a set of gears would be stripped before he went out, is now building one of the best lines of machine tools made in the country. His drawing was just as crude as his machine work. I can cite other such instances from my own experience. I do not think that a failure to take readily to shop work or to drawing is an indication that a man may not make a successful engineer. Referring to the order of the shop courses I would say that for twelve years at the Iowa State College we put the wood-working first. Since we have changed to the other order both our foundry and our pattern work have gone much more smoothly.

Professor Martenis: In reply to Professor Meeker I would say that the statement made in the paper was not an assertion. A student's inability to handle tools and to adapt himself to the various lines of shop work may be an indication of a mistaken calling. Frequently you find students who have gained the idea somewhere that nature has proposed an engineering career for them. After they have investigated the matter in a personal manner they find that they have guessed wrongly and naturally drift into other lines of work for which they are better suited.

Professor H. Wade Hibbard: During the discussion I have been listening to hear something about experimental and investigational work in the shops; the setting of problems for scientific study, analysis, test, and investigation. Are any of the college shops doing anything of that sort?

Professor E. F. Coddington: In answer to Professor Hibbard's question I will say that in the summer session at The Ohio State University this year we have one student who is doing that kind of work. While I am not familiar with the details I know that he is investigating the number of motions and the time required in setting up a jig and putting it in operation. We are, therefore, making a start.

Referring to Professor Flather's remarks I would explain that our shops are so congested that we have to give our courses in any order that we can. Hence we have arranged our shop so that we can alternate them. Sometimes we give foundry work first, sometimes the woodwork. It happens with us that the same man is at the head of both wood shop and foundry. His preference would be to give the two courses in parallel.

On the question as to whether one can determine from a student's shop work whether he has started on a wrong career or not, I will say that it is not safe to draw any conclusions from such incomplete data. Quite often our students do poorly with their theoretical and academic work, and on that account they take naturally to shop work in which they excel. Occasionally the reverse is true. The average man should do acceptable work in both shop and theory.

President Magruder: Can anyone answer Professor Hibbard's question about experimental engineering work being done upon shop tools?

Professor Walker: In the reorganization of our courses of study we have introduced, in the junior year for mechanical engineers after they have finished their actual shop practice, certain courses which consist mainly in making time studies, carrying out investigations, making studies of the methods of shop administration, preparing time cards, and work of that nature. This work is for future development so that I cannot speak from experience as yet.

Professor Adolph Shane: How many semester hours of each shop are offered by the University of Minnesota?

Professor Martenis: The hours are clock hours. To summarize these, in the wood shop there are 72 hours given to carpentry and 72 to pattern work; forge work requires 72 hours, foundry work 108, machine shop work 360 hours, and 18 hours additional are given in lectures to automobile and gas engine construction, a total of 702 hours of which 144 hours are devoted to lectures in the various branches.

President Magruder: In reply to Professor Hibbard I would say that I have not seen any engineering shop work such as he refers to done in any engineering shop in any of the forty-odd technical schools that I have visited in this country. I have seen some at the Municipal Technical School of the City of Manchester, England, under the direction of Professor Nicholson, where a thirty-inch lathe is fitted up with four or five dynamometers for measuring the pressures exerted by tools against the work. This, however, is in the laboratory and not in the shop.

At the University of Cincinnati I saw the beginning of a certain experiment about to be made a year and a half ago in the engineering laboratory, on the transmission of power and force in a shaper. The amount of force exerted by the tool of the shaper upon the work was being investigated. As Mr. C. C. Myers, of the University of Cincinnati is here, I would request him to give us some information on the subject.

Mr. C. C. Myers: We have about the same experiments being carried on at the University of Cincinnati as Professor Magruder mentioned as seeing in England. We have a Nicholson dynamometer and it is being used on experimental work both in the laboratory and in some of the coöperating shops. The shaper which Professor Magruder refers to has been used to give some interesting data, as indicator cards have been taken showing power consumption for the complete cycle. Several other tests on machine tools have been made which are interesting more from the manufacturers' standpoint.

Work similar to that described by Professor Hibbard has been carried on for some time but we find that the expense for materials in the way of castings and forgings for any series of tests proves to be a formidable proposition. We have not endeavored to duplicate Mr. F. W. Taylor's experiments in any detail. Manufacturing methods are gone into carefully, all details are analyzed and the complete problem discussed. There is not the need with our work to have actual demonstrations on machine tools in the laboratories as the students are meeting with similar demonstrations in the shops where they are working, and they are keen to recognize the weak points in any system or methods which may be proposed.

President Magruder: Professor Leutwiler, can you tell us something about what you are doing at the University of Illinois in the measuring of power of lathes and various other tools of that kind?

Professor O. A. Leutwiler: At the University of Illinois the machine shop is run on an efficiency system almost altogether. We have an efficient man at the head of it, but as a matter of fact, the students practically run the shop. The instructors are there to maintain discipline and to see that things run along smoothly. We have done some work along the line suggested by Professor Hibbard, namely, some tests on the cutting power of various types of steel. We have built one dynamometer for measuring the power required to take various-sized cuts on a lathe and this last winter one of our

seniors conducted an extended series of thesis tests on the cutting power required by various twist drills. The results were very good. Four years ago we attempted to measure the deflection of various kinds of machine tools. The apparatus was designed and built by one of our seniors in the class of 1909. The next year it was redesigned by another senior and several more tests were made. In our revision of the course we are now putting the shop work in the sophomore and junior years for mechanical engineers, and follow that work with a course along the line of shop management.

Professor Hibbard: At the University of Missouri, the shop work has been turned wholly into the manual arts. President Hill has for a long time had the belief that no man is broadly educated unless he has been educated in the use and coördination of hand, eye and mind, which is part of a liberal culture, and unless he has some appreciation of the making of things. He holds that no man is properly educated, therefore, unless he has had the manual arts. In order to overcome the prejudice of the average professor of Latin, and Greek, German, History and French for shop work, we have put manual arts into the professional school of education and have taken it out of the college of engineering. A few weeks ago the College of Arts and Sciences and of Liberal Education voted to accept for the degree of A.B. a certain number of hours taken in the manual arts. They would never have done it if we had called it shop work. The shop work, then, or more properly the manual arts have departed from the School of Engineering and gone into the School of Education. We are, in a modest way, starting a laboratory of engineering shop work. I hope next week to close a contract for a fairly large lathe driven by a high-power motor, adapted to take a forging of a ton and a half weight, to be used in learning, if possible, something in addition to what Mr. Taylor learned, after spending two hundred thousand dollars, about the breaking point of high-speed steels. To learn something also about the possible production of a lathe, to see what we can

do in the direction outlined by Mr. Myers and Professor Walker in the laboratory of engineering shopwork.

The University of Missouri School of Engineering is placed upon the professional basis with the five other professional schools, those of law, medicine, and so on. We admit no students to the engineering department direct from the high schools, but they must first take two years in the College of Arts and Sciences. We believe that most boys when they graduate from high school are just children who do not know whether they want to be engineers or doctors. We give them two years to find themselves in the atmosphere of the University. During those two years in the College of Arts and Science they get the mathematics that they need for entrance to the School of Engineering. The manual training high schools of our larger Missouri cities are splendidly equipped, some better than our own manual-arts shops. We expect to accept the work done in those better manual-training high schools, and not require any manual arts in the University. And we hope to see those manual-training high schools extend into the smaller places. We are going to have, we hope, at the beginning of our three years, the courses in manual arts. And early in those three years we shall eventually start the men in laboratory-engineering shopwork. We start this next year with some men in their third year, the last in the School of Engineering. Perhaps after a while it will be the second year, and then the first year.

Dean Woodward: I want to say how gratified I am to hear that report from Professor Hibbard. And going back to remarks of one speaker who said that his faculty did not think foundry work would be any use to a civil engineer, I would say that the foremost engineer that we had in St. Louis, the ex-president of one of the American societies, graduated from Washington University as a civil engineer. In the course of five or six years he became the most eminent mechanical engineer in the city and now he leads as an electrical engineer. He is an all-round man.